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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

WHAT AN EMPLOYER MAY EXPECT OF THE YOUNG ENGINEER.

When an employer is looking for a young engineer just out of college, one of two things must be expected—either the employer must be satisfied with a young man who has a broad preparation, but who has not made a thorough study of any branch of engineering, or he must be satisfied with a specialist who has had but a narrow preparation. This preparation, as time passes, will become narrower and narrower if the graduating student is to keep pace with the art. In each case active practice tends to correct the deficiencies of the school training; and although it would seem that in the end the first method would give the best results, it must not be forgotten that, as it is frequently stated, this is a day of specialists, and it seems but natural that this should be recognized in the technical schools.

ELECTRICITY IN COAST FORTIFICATIONS.

An interesting instance of the rapid extension of the use of electricity is furnished by the fortifications distributed along our coast. A few years ago the electric light was introduced to add to the comfort of the garrisons and to provide better illumination of the works. Once a generating plant had been installed, there was at hand a supply of power in a convenient and easily controllable form, and this led to its use for purposes which were not contemplated at the time the plant was installed.

Various Uses of Electricity in a Fortress.

Electric fans have been put in to make the living quarters more comfortable in hot weather, and electric motors have been adopted for training the guns, a class of work for which they are particularly well adapted. Motors are used to drive the ammunition hoists and to do other work which before had either been done by hand or some less satisfactory power. Searchlights have been installed, enabling a fortification to sweep the sea at night. The various posts of the fortress are connected together by telephone, so that the commandant is in touch at all times with the entire garrison, and can instantly transmit orders to any point. The various fortifications along the coast are tied together by telephone and telegraph, so that on the appearance of the enemy at any point all the fortifications would be informed of it. Submarine mines are controlled electrically, and even the guns may be fired by this means, by an officer at some distant point. By means of wireless telegraphy, a fortification can be kept in touch with the scouting vessels, and would be informed of the approach of the enemy long before he is visible from the coast. The telautograph may be brought into service for transmitting orders, and electric signaling lights are replacing the older types. Electric lights are used for range-finder crosshairs, for lighting the range-finder stations; and electric clock circuits furnish accurate time to all parts of the fortification. To ensure the continuity of these manifold service, accumulators are now installed, so that there will at all times be a constant and reliable supply of power.

Importance of the Electrical Equipment of a Fortress.

Thus, from being at first a small auxiliary, the electrical equipment has extended until it is now probably the most important part of the entire equipment of the fortress. While, of course, the intention of the fortress is primarily to provide a suitable place for the coast guns, the guns themselves would be useless unless means were provided for handling and operating them. The electrical equipment has become the controlling factor, for it not only trains the guns and fires them, but transmits the order to fire. It is found in the fortress in nearly all of its applications, and for its proper management men are required who are skilled in all branches of electrical application. It furnishes an instructive example of how quickly a new agent may be employed for an old work, and how its success in one application leads to its further use, until it drives from the field all rivals.

THE TRACKLESS TROLLEY

Although there have been but few instances where the trackless trolley, or the electrically operated omnibus, has been introduced, it would seem that the advantages of this method of transportation will be recognized before long. This system has been tried, with reported success, abroad, and we believe it will soon be in operation in several places in this country.

Trackless Trolley Might Be Used where Traffic Is Light.

There has been a remarkable growth of the trolley roads of late—a growth which hardly seems to have been justified by the needs of the country. Wherever there is

a demand for transportation facilities, a trolley road is projected and, in many cases, constructed, although the traffic conditions do not always warrant the necessarily heavy investment. Would it not be well, in many of these cases, to try first the trackless trolley? The expense would be far less—probably not more than one-tenth that necessary for the trolley road. If it were found not to pay, the loss would not be great; and if the development was such as to make a railroad necessary, there would have been practically no loss.

Of course, for the best conditions, there should be good roads, but the introduction of the trackless trolley brings into the field a new ally for the good roads movement, while the trolley roads, however well laid, can not but be some obstruction on the highway. It would seem to be a wise thing for automobilists and horse owners who are interested in road improvement to favor the trackless trolley, rather than a trolley road, wherever such a system would satisfy the requirements of the district where the road is contemplated.

THE SCHENECTADY RAILWAY COMPANY'S SYSTEM.

On other pages of this issue is described the city and interurban system of the Schenectady Railway Company, Schenectady, N. Y. Situated as Schenectady is, as the natural hub from which radiate several lines traversing a territory famous for its picturesque environment, and tapping several cities of considerable commercial importance, the system is worthy of study. The excellent condition of the various divisions, and the splendid community of interest which exists between the employés and the executive and operating departments, merit investigation—that similar conditions might exist throughout the country. The convention of the American Street Railway Association, holding forth at Saratoga, September 2, 3 and 4, will bring to this part of the country a host of men who are familiar with every detail of railway operation, and this system will no doubt do its part in presenting an opportunity for entertainment and investigation.

WHY HAS NOT THE TELAUTOGRAPH COME INTO GENERAL USE?

It is often true that great inventions, involving in their development a vast amount of ingenuity, expense and persistent effort, are practically sidetracked upon the eve of complete reduction to practice by some change in the commercial conditions that originally called them forth from the brains of their inventors, or by some unforeseen adaptation of another device for filling the same public need in a different way. The application of this to that exceedingly ingenious invention, the writing telegraph or "telautograph," is being witnessed to-day; the usurping factor that inhibits or delays the use of this wonderful instrument being the speaking telephone. Even the day of its extensive use in combination with the telephone seems to be indefinitely delayed. The telephone alone has so far completely filled the public need for quick and informal intercommunication. One is reminded, by an interested contrast, of the back pages of some old numbers of *Harper's* along about 1877 or 1878, in which were shown some pictures of the then new "Bell telephone," illustrating a form of the old "double crown" magneto telephone arranged upon a subscriber's desk, with a telegraph set, on a shelf at one side, as a reserve or auxiliary apparatus. A few numbers later the same magazine describes the Hughes microphone in its earliest stages. The influence of this latter invention in converting the telephone from a merely scientific apparatus into a commercial agent of vast utility, put a quietus upon any need of the telegraph as an attachment to the telephone.

Ingenuity of Invention no Assurance of Commercial Success.

On the other hand, also, the ingenuity displayed in a developed invention, or the pains and labor involved, are in themselves no assurance that the invention is going to fill an extensive need. An instance of this is the proposed use of the phonograph as a labor-saving intermediary in business correspondence. We have in mind also some almost superhumanly ingenious machines designed to take the place of telephone operators, in examining which we were forced to the conclusion that the inventor's time had been simply wasted on devices which were a monument of investment of brains and labor and were a success, mechanically speaking, but which were underbid from the start, so to speak, by better methods of accomplishing the same object, in ways that recognized more closely all of the practical conditions of the problem. Thus it happens that the work of Gray, of Messrs. Pollak & Virag and of Gruhn, in attacking this problem in various interesting ways, is delayed in consummation by the agency of intercommunication mentioned actually in possession. Moreover, the use of the telephone, during its quarter century of life, has impressed itself upon the business world by effecting a decline in the amount of written communication, which it replaces so handily. The convenience of quick delivery of messages, of comparison of information between individuals widely separated, and the possibility of getting through a vast deal of business by modifying its conduct so as to make it, so to speak, "telephonable," have had such an effect that today business men would not submit to making use either of the army of messengers or the multiplicity of written messages that the elimination of the telephone would involve.

Writing Telegraph Valuable in Combination with the Telephone.

The proposition of the consolidation of the writing telegraph with the telephone, that has been brought up from time to time, to fill a supposed need, seems to us to have value that will prevail sooner or later, the question of its adoption being dependent probably upon the history of telephone management within the next few years. To our view, a writing telegraph attachment to the telephone, reduced to as practical a form as the present telephone substation, would have a marked and beneficial effect upon the telephone service itself, as well as proving to be a great addition to the public convenience. There are a large number of operating delays and "bad calls," representing a vast aggregate of friction and delay in the handling of the telephone service, that would be eliminated, or at any rate much reduced, by such a consolidation of these two inventions.

THE RELATION OF SCIENCE TO COMMON LIFE.[1]

BY J. M. MACFARLANE.

My theme is "The Relation of Science to Common Life," the life of the mass of individuals, of the nation, if you will. A very unacademic subject, you will say, as measured by the older standards. I chose it on that account. In not a few university centres, the time has not long gone when such a subject would have been curtly dismissed with the remark, "We have nothing to do with common life; we follow our own high educational aims." Too often the universities have stood aside in cold and unsympathetic isolation—shall I not also say in helpless disfavor—while the busy thinking world outside has carried forward the beacon lights of truth and progress. Listen to Whewell when, as master of Trinity College (Cambridge), he went up to London fifty years ago to deliver his notable address before the Royal Institution. Speaking on "The Influence of the History of Science upon Intellectual Education," he said: "I venture to address you, relying upon an indulgence which I have more than once experienced. Of such indulgence I strongly feel the need, on various accounts, but especially that, being so unfrequently in this metropolis, I do not know what trains of thought are passing in the minds of the greater part of my audience who live in the midst of a stimulation produced by the lively interchange of opinion and discussion on the prominent questions of the day." Uttered soon after the exhibition of 1851, and when the scientific world was entering on new conquests, such an apology may seem unaccountable. Happily, our university presidents of to-day are more in touch with the throbbing, vibrating life of humanity, even though they may not claim the profundity of thought that lived in the master of "Trinity."

If there be one characteristic more than another of our age and day, it is the steady welding and cooperative development proceeding among the leading races of the world. Nowhere is this seen on so phenomenal a scale as in our country, where with the Anglo-Celt, Jew and Greek, Frank and German, Italian and Norseman together ply the arts of peace. And why such a commingling of human lives? The answer may be given, and so far well, that here liberty is assured to all, that equal rights and equal opportunities come to all. Back of this, however, is the basic fact that in this country scientific progress has been comparatively unhampered by costly patent laws, by hereditary vested rights, by lands being held in the hands of a few. But perhaps above all, and permeating all, though often silently working, there exists a keen and rapid method of inductive reasoning that carries forward the individual and the community on progressive and yet safe lines. It is this method, applied to all branches of science with increasing exactness, as human freedom increasingly asserted itself during the bygone century, which has culminated in the marvelous scientific position occupied by the country to-day.

What relation then has science, and should it have, to our universities on the one hand, and to common life—to the mass of free earnest thinking people, on the other? In attempting to answer we must constantly keep in view tradition and history—our relation to our ancestors, real or imaginary. We all, like the Chinese, worship these ancestors—at least in their relations—and they worship them most powerfully who are furthest removed from the land that gave them birth. So it is that we fear to break with the past, and inherit incongruous combinations. Says Whewell: "You will not be surprised to be told that our modern education has derived something from the ancient Greek education, because you know that our modern science has derived much from the ancient Greek science. You know that our science—in the ordinary sense of the term—has derived little from the ancient Romans. . . . But if we take the term science in a somewhat 'wide' acceptation, we shall derive from the Roman history not a negative but a positive exemplification of our proposition. For in that wider sense there is a science of which Rome was the mother, as Greece was of geometry and mathematics. The term science may be extended so widely as to allow us to speak of the science of law—meaning the doctrine of rights and obligations, in its most definite and yet most comprehensive form; in short the science of jurisprudence. . . . And thus two of the great elements of a thorough intellectual culture—mathematics and jurisprudence—are an inheritance which we derive from ages long gone by; from the two great nations of antiquity."

So far Whewell, who in attempting to elevate Roman law to the dignity of a science forgot that much of it was unscientific to the last degree, and tended to produce, not organic national equilibrium, but to set the patricians against the plebeians, and both against the bondmen, who often showed finer qualities than either. Little wonder is it that Rome fell, unsaved by her laws.

Let us see whether a different viewpoint and source of origin for the science of law and equally for all scientific relations might not be obtained. Huxley thus puts it: "It is a very plain and elementary truth that the life, the fortune and the happiness of every one of us and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. . . . Education is learning the rules of this mighty game. In other words, education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. . . . The object of what we commonly call education—that education in which man intervenes and which I shall distinguish as artificial education—is to make good defects in nature's methods, to prepare the child to receive nature's education. . . . In short all artificial education ought to be an anticipation of natural education. And a liberal education is an artificial education which has not only prepared a man to escape the great evils of disobedience to natural laws, but has trained him to appreciate and to seize upon the rewards which nature scatters with as free a hand as her penalties." To pursue Huxley's reasoning to its ultimate limit, advanced teaching of all the laws of nature is the highest function of the university in relation to our common life. In other words, to make each man who leaves its portals most highly qualified for useful, intellectual, manly life. But, as I hope to show later, this qualification is to enable him to use wisely—not meanly—the forces around him, so as to build society into an organism.

Therefore, every upright pursuit in life which man enters on should have the highest principles and practice governing it represented and taught in our universities, by the best men in the most perfectly equipped manner. This may be an ideal at present. Granted, it is nevertheless one toward which, I am persuaded,

[1] Abstract of Sigma Xi Society address, June 18, 1903, before the chapter of the University of Pennsylvania.

every university must move. In this manner science will confer the dignity that is deserved on the physician's scalpel, the bricklayer's trowel, the chemist's test-tube, the engineer's lathe, the biologist's microscope, the agriculturist's spade or ploughshare.

It is a property of most scientific questions that they project themselves into the future. Whether we accept the teachings of Kidd's suggestive couple of volumes or not, his prophetic outlook into the future is inspiring, and despite destructive criticisms his principle of "projected efficiency" is one that every true scientist tacitly believes in and works up to.

While it will gladly be conceded that few if any countries foster scientific advance more than America, it will as readily be conceded that this has been mainly on the applied side, and that much remains for accomplishment in non-remunerative educational equipment. Here I place in front rank the need for spacious and splendidly furnished museums for all the sciences. Those of us who have walked, time and again, through the mechanical, the chemical, the zoological, the mineralogical and other sections of the South Kensington Museum, or corresponding ones of the Continent—not to speak of many local museums of lesser repute—know that we have nothing to compare with them. Suppose we make observation for a time in the mechanical section, where accurate models may be even seen at work. There the schoolboy lingers enquiringly before them, and he thus forms great conceptions of man's inventive relation to the world forces around him. The factory worker learns how his machines have grown, have been evolved, and how he may possibly perfect them further. For the college and university teacher these collections furnish comparative and concrete illustrations by which a lasting picture is fixed in the mind. Such institutions are costly to erect, to furnish, to man, and to support annually. Their high educational worth must be gauged not by the fruits of years, but of decades and centuries, for the mental stimulus they afford is often hidden away and silent. The question of cost should be a minor consideration in planning such undertakings, amid the corporate and individual wealth that characterizes such centres as our own. Civic pride and loyalty, material pride and loyalty, pride in and loyalty to our highest human development should be sufficient impelling force. Here let me say, with all caution and reserve, but yet with perfect conviction of purpose, that when we read or learn of lavish individual expenditures, for individual gratification alone, it should arouse in every one of us the desire to so mould public opinion that such superfluous ostentations shall cease. If the owner of the wealth thus diverted can be shown that his wealth can most patriotically be expended in building up the country's institutions, then we have successfully done battle for the right.

A note of warning is sounded against the dangers of specialization. I trust that every one directly or indirectly connected with our institutions realizes its dangers. Though Darwin pathetically confessed as to its effects, no one has put it more forcefully than Stuart Mill, who says: "The increasing specialization of all employments; the division of mankind into innumerable small fractions, each engrossed by an extremely minute fragment of the business of society, is not without inconveniences, as well moral as intellectual, which if they could not be remedied, would be a serious abatement from the benefits of advanced civilization. The interests of the whole—the bearings of things on the ends of the social union—are less and less present to the minds of men who have so contracted a sphere of activity. . . . This lowering effect of the extreme division of labor tells most of all on those who are set up as the lights and teachers of the rest. A man's mind is as fatally narrowed and his feelings toward the great ends of humanity as miserably stunted, by giving all his thoughts to the classification of a few insects, or the resolution of a few equations, as to sharpening the points or putting on the heads of pins. The 'dispersive specialty' of the present race of scientific men, who, unlike their predecessors, have a positive aversion to enlarged views, and seldom either know or care for any of the interests of mankind beyond the narrow limits of their pursuits, is dwelt on by M. Comte as one of the great and growing evils of the time, and the one which most retards moral and intellectual regeneration. . . . He demands a moral and intellectual authority charged with the duty of guiding men's opinions and enlightening and warning their consciences; a spiritual power whose judgments on all matters of high moment should deserve and receive the same universal respect and deference which is paid to the united judgment of astronomers in matters astronomical." We must acknowledge to a large degree, the saneness of Mill's position, but if we all cease specializing one day in the seven at least, the spiritual power desiderated will have opportunity to dwell in our midst. The Jewish Sabbath is by no means the worn-out institution that some would have us believe.

Another rock ahead in the channel of progress demands most careful consideration and steady action. Our present-day political and economic systems often foster methods by which science and scientific discovery are degraded or robbed of their true value, while the scientific worker is often defrauded of that reward that should come from sturdy effort of mind and hand. It has truly been said that "crafty men contemn studies, simple men admire them, wise men use them." The founding by Besant of what might be called "the authors' mutual protection society" marked an epoch in the history of English literature. No such organization has yet been evolved to foster and protect scientific discovery. But to put the whole question on a much higher plane than that of mere financial well-being, I venture to say that since science stands for accuracy, probity, clear statement of fact, unveiling of error of every kind—whether intentional or unintentional—it can have no sympathy with the deceit and chicanery that are so rampant around us, and that threaten at times even to swamp the high ideals of our universities.

Are the laws of science then, as we ordinarily understand these, to be our sole guide and rule in life? This enquiry causes me to recur to Huxley's picture of life already quoted. Are all the moves on the human chess board to be dictated only by thoughts of self-interest and self-preservation, or even by thoughts on behalf of our friends and offsprings, as Huxley, in his later days, attempted to prove. Some of the "moves" operated repeatedly in the world's past have given us an environmental human outcome, products that we call "strong lives," "strenuous lives," "unscrupulous lives," "useful lives," "instructive lives." But the greatest type, and the one that we almost unconsciously worship is "the beautiful life."

Every organism from amœba to man lives by a process that we may call "organic molecular equilibrium." When the supplies of life energy and food integration exceed the dissipations and disintegration, growth and development proceed. When both are balanced maturity has been attained. When the converse to the first holds true, decay sets in. Applying this fundamental principle to our common

human life, the highest human scientific aspiration might be expressed in the aphorism "society an organism." Such a condition society is far from having attained to. But like all organic bodies, if it is rightly to perform its functions, and to perpetuate its like, such it should become. At present, even in its hightest expression, it consists of human molecules that often exhibit abundant energy, that undergo permutations and combinations, that show affinities and repulsions, but that lack some form of energy necessary to link them into an organic whole, to give them social equilibrium and stability. Society has been struggling through millennia to become an organism, has been searching for that energy and that source of energy that will give it life equilibrium. At times and in places the result seemed to have been achieved, only again to be impaired, or lost amid a chaos of discords, by the disrupting agency of one or of a few unscrupulous souls, who have acted like a disorganizing ferment on the organizing mass.

Though unfashionable with many to-day, and not least with the followers of science, the only motive form of human energy that has stood the test, and that is stronger to-day than ever before, is the power, the force of love, of compassion, of sympathy, as communicated by the greatest social lawgiver the world has seen. The early founders of Christianity were charged with it, and for three centuries they shook and finally subdued the Roman empire. We have it in our midst and it lives through all the upheavals consequent on human competition, on commercial war. In our hospitals, in our college settlements, in our church and public beneficences, in our increased regard for human life, we feel the effects of this energy, though we see it not. The social settlements of Owen and others were truly preliminary nineteenth century scientific experiments to test the strength of the law of love, and the amount of this energy needed to vivify and unify the social organism. Like thousands of scientific experiments before and since they partially failed, but their failures and successes have been recorded, so that succeeding experimenters might carry the enquiry to a successful issue.

The fetish of unbridled commercial competition which has too long lorded over us, is in many ways inimical to our highest interests. It can be a helpful servant if kept in subjection, it becomes a harsh tyrant if worshipped as a god. It can not retain supremacy alongside the gospel of peace and love. If so, the latter suffers or becomes effaced, and mankind becomes the loser.

Tangential Water-Wheel Efficiencies.

At a recent meeting of the Pacific Coast Electric Transmission Association, George J. Henry, Jr., read a paper on "Tangential Water-Wheel Efficiencies." The conclusions which he has reached are the result of an elaborate series of experiments carried out in a special laboratory since 1899, with a view to determining scientifically and practically the relative advantages of different bucket shapes. To obtain the best efficiencies, it is necessary to have the proper pipe line, gate valves, nozzles, water-wheels and buckets, wheel gates, wheel pit and trail-race, and all of these must be properly designed for the particular conditions under which they are to operate; and all will vary with the head or pressure, the quantity of water, and the revolutions which the wheel is to make. Many a water-wheel bucket has been overworked for years and then charged with losses that occur because of its being improperly worn, due to this overwork. Again, buckets are frequently charged up with all kinds of losses, which are really due to something for which the bucket is not responsible. Pressure or wheel diameter, or speed on a given wheel can not be varied radically without materially altering the efficiency. The various losses occurring at the bucket are due to the discharge velocity with which the water leaves the bucket, air and surface friction inside the bucket, imprisoned water in the bucket, variation in the stream form, producing erratic conditions of impact, the loss occasioned by the stream being displaced by the entering bucket, and eddy currents in the buckets.

To correct these losses, the following methods are suggested: The water should move in a curved path on the bucket surface and turn through an angle of as nearly 180 degrees as possible. If the water moves in a smooth curved path and the stream form is retained, spreading out gradually with a fine fan-like discharge, and the least number of buckets used, then the air and surface friction will be a minimum. The imprisoned water will cause little loss if the bucket surfaces are smooth and so shaped that the water will leave the wheel freely. Displacement of the stream can be avoided by a proper shape of the cutting edge and dividing knife.

The above losses and considerations for their prevention are all of such a nature —so entirely interdependent—that their quantitative value can not be predetermined, except in a general way. In designing a water-wheel, it is certain that the exercise of the most careful judgment is necessary in laying out the surfaces.

The author then describes results of tests on a large number of different shapes and styles of buckets, and photographs were shown, illustrating the behavior of the stream of water when it impinged upon the buckets.

The First Standard-Gauge Electric Railway in Prussia.

A consular report states that Berlin has entered upon the employment of electrical traction for suburban service on the state railways of standard gauge. Since the middle of May, experiments have been in progress on the lines of the Potsdamer Station in Berlin—the focal point of suburban traffic within the city limits—to Gross Lichterfelde, a distance of five and one-half miles. These experiments have been entirely successful, and the regular traffic was begun on July 15, with trains of three cars each, with a ten-minute schedule in each direction. Current is supplied from the southwestern power station of the already existing belt line railway, and is transmitted over an insulated third rail laid beside the track. Each train is made up of one second-class and two third-class cars, each sixty-three feet long by nine feet wide. The weight of the total train is 128 tons, and the capacity is 200 passengers seated. The third-class cars are placed one at each end of the train, each being equipped with one motor. The second-class car is in the middle of the train, and carries no motor.

The opening of this line may mark the beginning of a general change from steam to electricity for the important and rapidly growing suburban service of Berlin. A second line, which leads to Cöpenick, several miles distant up the Spree, is already being converted to electricity and will be put in service during the summer.

The Manufacture of Brick.

The current volume of the transactions of the American Ceramic Society contains a paper by Samuel B. Peppel, entitled "Further Contributions to the Manufacture of Artificial Sand Stone or Sand Brick." This is a new building material, formed by mixing sand and lime, which is then hardened by treating it, while under pressure, with live steam. The author describes the raw material, its preparation and the behavior of the mixture in the press, methods of hardening, testing and the mechanical equipment of the works. He then discusses the merits of the various systems of manufacture.

TWO SIMPLE METHODS FOR LOCATING FAULTS IN CABLES.

BY EDWIN F. NORTHRUP.

The most common fault occurring on telephone lines consists of a cross between two lines or a ground on one or more lines.

If the fault occurs in a lead-covered cable and one or more wires can be found in the cable, which are not defective, or if there are outside wires, with terminals at the two ends of the cable, a cross or a ground can be located in a very simple manner and without any calculations more than a simple multiplication and division. The essential apparatus will consist of a straight piece of bare resistance wire, a scale, such as a meter stick and a millivoltmeter, or a detector galvanometer, which will indicate a fraction of a milliampere; and a number of cells of battery. We will describe two methods.

I—TO LOCATE A CROSS WHEN AT LEAST ONE GOOD WIRE CAN BE FOUND IN THE CABLE.

This first method to be described may be applied when there is at least one good wire in the cable having substantially the same length as the defective wires.

In Fig. 1, the wires 1, 2, 3, 4 in the cable are assumed to be of the same length (this is not always true, but will be considered later) and the wires 1, 2 and 3 are crossed, the wire 4 being free from a cross. The length 1 of the cable, in feet or miles, is assumed to be known. It is required to determine in the simplest possible way the distance from the station A to the cross C. Call this distance r_1. Let the tester at station A have the good wire joined to any of the crossed wires at station B, as indicated at S, Fig. 1. Now choose on a straight rule 1,000 arbitrary divisions, say millimetres, and fasten a binding-post at the beginning and end of this distance. Stretch a piece of about No. 24 German silver or iron wire between the posts so as to lie over the scale and continue the wire beyond the right-hand post for a length exactly equal to that between the posts, and fasten the end to another binding-post placed at any convenient place. Calling the posts, counting from the zero of the scale, *f*, *g*, *h*, join the end of the good wire to *h* and the end of one of the crossed wires to *f*. Connect one end of the battery to one of the other crossed wires and the millivoltmeter or detector galvanometer to the posts *f* and *h*. If the end of an insulated wire joined to the free pole of the battery be now touched upon the wire stretched over the scale, a point may be found where the galvanometer will show no deflection. The distance to the fault will then be simply the scale reading from *f* multiplied by the length of the line and this product divided by 1,000. Thus suppose a balance is obtained when the scale wire is touched 342 divisions from the left-hand end of the scale and the line is 3.4 miles long. Then

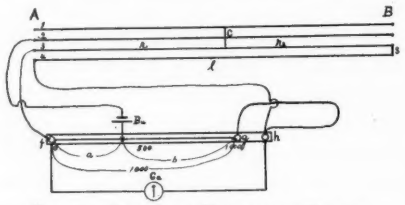


FIG. 1.—LOCATING FAULTS IN CABLES.

r_1 or the distance to the cross is $342 \times 3.4 \div 1{,}000 = 1.1628$ miles.

If the cross has a very high resistance the battery current will be small and several cells or even 110 volts may be needed to make the galvanometer sufficiently sensitive. If a high voltage is used, it is advisable to insert some resistance in series with the battery or source of current to avoid burning out the touch wire *f* to *h*, by accident in case the resistance of the fault suddenly drops when the high voltage is applied. The algebraic theory of the above method is as follows:

Referring to Fig. 1 for the meaning of the letters, $\frac{r_1}{r_2 + l} = \frac{a}{b}$, but $r_2 = l - r_1$ if the wires in the cable have the same length.

Hence $\frac{r_1}{2\,l - r_1} = \frac{a}{b}$ and solving for r_1, $r_1 = \frac{2\,a\,l}{b + a}$.

Since $b + a$ has been made equal in length to 2,000 scale divisions $r_1 = \frac{2\,a\,l}{2{,}000} = \frac{a\,l}{1{,}000}$.

If the wires 1, 2, 3 are grounded at C

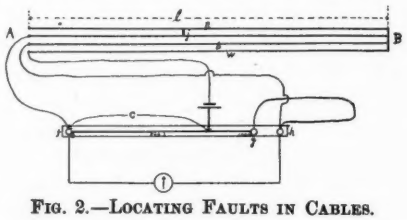


FIG. 2.—LOCATING FAULTS IN CABLES.

instead of crossed, then the side of the battery which was before joined to the crossed wire would now be connected to earth and the same subsequent procedure followed.

II—TO LOCATE A CROSS WHEN TWO GOOD WIRES ARE AVAILABLE.

Method I assumes that the several wires in the lead-covered cable are all of the same length and that at least one good wire exists in the cable. Now it may often happen that one wire, as the good one, is a central wire in the cable, and that the crossed wires are outside wires which on account of twisting around the inside wires are of a greater length. In this case r_2 does not equal $l - r_1$ (Fig. 1), and an error would be introduced. By the method to be described the distance to the fault (which may be a cross or a ground) can be determined as a certain fraction of the length of the lead pipe, and this distance will be independent of the length of the faulty wire in the pipe or of whatever twist it may have. The only assumption which has to be made when extreme accuracy is sought is that the faulty wire shall twist in the same uniform manner throughout the entire length of the lead-covered cable. If it starts as an inside wire or an outside wire, it must continue as such. The location of the fault is determined by taking two readings with the arrangement as described for using method I, but with the connections made first as shown in Fig. 2 and second as shown in Fig. 3.

In Figs. 2 and 3, W and *b* are two good wires, and these wires may be in the cable or outside the cable and have any resistance, and 1 is crossed with *n*, or 1 may be grounded. The wires are joined together at station B, and at station A connections are made to the slide wire apparatus, first as shown in Fig. 2. It is required to find the distance *x* from station A to the cross or ground at *j*, this distance being measured along the lead-covered cable and having no reference to the actual length of the wire. Let the reading taken for a balance with the connections of Fig. 2 be called C. Now disconnect wire *w* from the battery and connect the battery to one of the crossed wires or to ground, according as a cross or ground is to be located. The connections will now be as shown in Fig. 3. Let a second reading be taken for a balance and call this reading S. Then if 1 is the total length of the lead-covered cable, the distance *x* to the fault from station A, measured along the cable is $x = l\,\frac{S}{C}$.

In order that a balance may be obtained in the first instance, the wire *b* must have a greater resistance than the wire 1, or part or all of the wire between the posts *g* and *h* must be short-circuited. If it is found that to obtain a balance in the first instance the toucher *t* would have to touch the wire *f*, *g*, *h* to the right of the post *g*, then any arbitrary resistance may be added to the wire *b* until the

reading c comes on the scale between f and g. This resistance, if used, must be left in during both readings. It is better to add resistance to b than to short-circuit the wire g to h as the scale readings will be longer and hence more accurate. As an illustration of the formula above, suppose the first reading c is 400 scale divisions and the second reading 200 scale divisions, and suppose the lead cable is 3,200 feet long, then the distance from station A to the fault is simply $x = 3{,}200 \times \frac{200}{400} = 1{,}600$ feet.

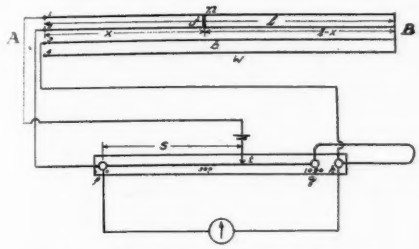


FIG. 3.—LOCATING FAULTS IN CABLES.

As the above two methods require no knowledge of resistance formula, or in fact any electrical knowledge whatever, they may be readily applied by unskilled linemen and faults located, especially where the second method can be applied, with considerable accuracy. A special advantage of the second method is that it is only necessary to know the length of the cable and not the length or resistance of the two extra wires used. The algebraic theory of the second method is as follows: Figs. 4 and 5 are diagrammatic representations of Figs. 2 and 3, corresponding letters having like meanings. With the conditions as shown in Fig. 4, $\frac{l}{b} = \frac{c}{a}$ or $b = \frac{a}{c} l$.

Since $f\,g = g\,h$ in resistance, if 1 is greater than b in resistance, the balance can not be found on the scale. In this case, short-circuit $g\,h$ or, preferably, add an arbitrary resistance to wire b. Changing the connections to be as shown in Fig. 5. $\frac{x}{l - x + b} = \frac{s}{r}$ and substituting the value of b from the first equation.

$$\frac{x}{l - x + \frac{a\,l}{c}} = \frac{s}{r}, \quad \frac{c\,x}{c\,l - c\,x + a\,l} = \frac{s}{r} \text{ or } x = \frac{l\,s\,(a + c)}{c\,(r + s)}$$

but as $a + c = r + s$, a constant $x = l\,\frac{s}{c}$.

As b eliminates and w does not enter the equation, their resistance need not be known.

It has been shown how the two methods described may be applied with simple apparatus which any lineman can rig up in a short time and still obtain accurate results.

An apparatus called the lineman's fault finder has, however, been recently placed upon the market for locating faults by the above methods with ease and accuracy. By going into certain refinements such as selecting a long wire of great uniformity for the slide or touch wire, and by substituting for the extra length of wire, g, h, a resistance coil having accurately the same resistance as a length of 1,000 scale divisions of the slide wire, and by using a sensitive galvanometer, etc., an apparatus may be made which, by method II at least, will locate faults with the highest possible accuracy, and with the greatest simplicity and despatch.

The writer is indebted to C. L. Goodrum, of the United Telephone and Telegraph Company, of Philadelphia, for the first suggestions of the usefulness of the above methods of fault locating.

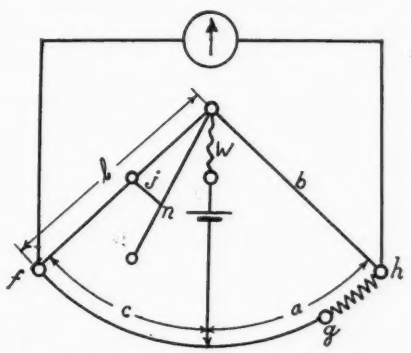


FIG. 4.—LOCATING FAULTS IN CABLES.

New Oil Engine.

In a type of oil engine which has attracted much favorable notice the oil is vaporized and ignited without the use of any external source of heat. The main drawback has been that the engine would not run indefinitely with light loads, owing to the explosions not occurring with sufficient frequency to keep the igniting portion at a sufficiently high temperature. A modification of this type of motor just brought out by the Britannia Company, of Colchester, England, is claimed to be free from this drawback. The vaporizer is arranged, as usual, at the back of the cylinder. On the suction stroke a vapor valve is opened by the cam shaft, and through this valve air is drawn into the cylinder through the vaporizer, into which at the same time a little oil is sucked through an automatic valve. This mixture of air and oil is in itself too rich to be explosive and the main supply of air is drawn through a separate air valve into the cylinder. Two passages connect the vapor valve with the cylinder. One of these is large and straight, while the other is narrow and U-shaped. The lower portion of the U contains the igniter—a piece of metal having ribs, which enable it to absorb heat readily when the explosion takes place. This piece therefore becomes and remains red hot, while the rest of the vaporizer is only at a black heat. The vapor which is drawn through this igniter on the suction stroke is far too rich to burn, but on the compression stroke air is forced back into the igniting piece and provides the necessary oxygen for the vapor already there to ignite. None of the exhaust passes through the igniter, which is consequently not cooled down in the case of a missed explosion. The proportion of oil and gas used is regulated by throttling the air supply. As already stated, part of this air is drawn through the vaporizer and the rest through the air valve. If the admission to the latter is throttled a greater proportion of the air used will be taken through the vaporizer and will carry with it a proportionately greater amount of oil. The maker claims that, once started, the engine will run absolutely without attention for several hours.

German Telegraph and Telephone Statistics.

Telegraphic and telephonic statistics for 1900 have just been printed in the Statistical Yearbook for the German Empire.

Telegraphs—In 1900 Germany had 24,471 telegraph offices, with 36,000 instruments in operation; Great Britain, 11,512 offices and 38,000 instruments;

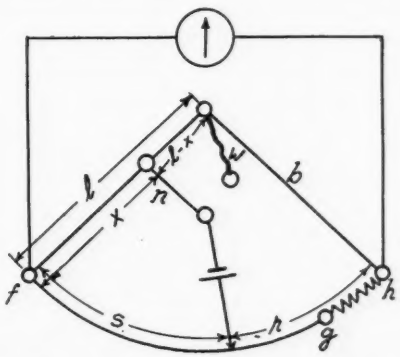


FIG. 5. LOCATING FAULTS IN CABLES.

and the United States, 22,954 offices and 81,000 instruments.

The number of telegraphic despatches transmitted in 1900 was:

Great Britain	92,000,000
United States	63,000,000
France	50,000,000
Germany	46,000,000

Telephones—In Germany there were 2,411 cities or towns having public municipal telephone systems, with 305,795 connections. France had 1,199 public telephone plants, with 72,480 connections.

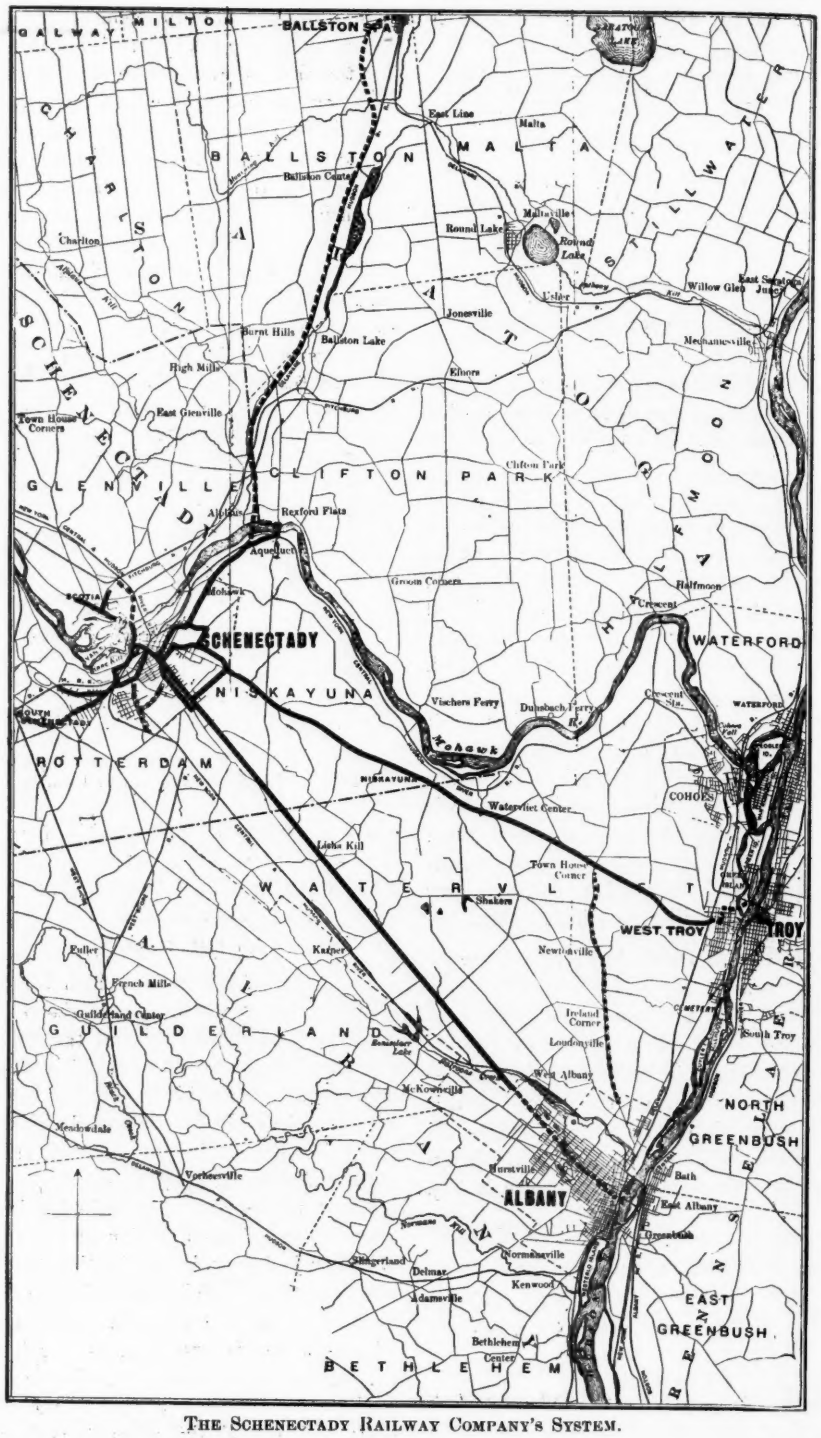
The City and Interurban System of the Schenectady Railway Company.

THE city and interurban system of the Schenectady, N. Y., Railway Company offers an attractive proposition for study from many points of view. A number of features of more than ordinary interest contribute to make the operation, maintenance and utility of this system of electric traction remarkable. The convention of the American Street Railway Association, meeting at Saratoga, N. Y., September 2, 3 and 4, will centre interest to a greater or less extent in this section of the country, and at this time a survey of the Schenectady railway system is appropriate and highly interesting.

The city of Schenectady is located about 160 miles north of New York city, on the line of the New York Central & Hudson River Railroad. Its topographical position makes it the natural centre of a system of interurban roads radiating in several directions to a number of feature cities in New York state. Albany, the capital of New York state, is fifteen and one-half miles southeast of Schenectady, and a magnificent double-track road, stretching in an almost perfectly straight line, has been in operation for over two years. To the north, to Ballston Spa and Saratoga, whose numerous mineral springs make this latter city one of the most popular resorts in the country, a double-track road about twenty-two miles in length is about completed. Troy, a manufacturing city of large proportions and of great commercial importance, is sixteen miles to the east, and a double-track road was completed between Schenectady and this city in March of the present year. To the south, a road is contemplated to South Schenectady and Altamont, a distance of eleven miles; while to the west, a connection has been made with the Fonda, Johnstown & Gloversville Railroad, making it possible to ride from Albany to Gloversville, a distance of fifty miles, without change of cars.

In addition to this intercity service, which affords the pleasure-seeker the greatest variety of entertainment with regard to picturesque scenery and safe high-speed riding, the company has a city proposition to handle which approximates very closely to metropolitan conditions, in handling the rush-hour traffic which is imposed upon the system, due to the assembly and retirement of the employés of two of the largest manufacturing interests of the country, namely, the works of the General Electric Company and those of the American Locomotive Company.

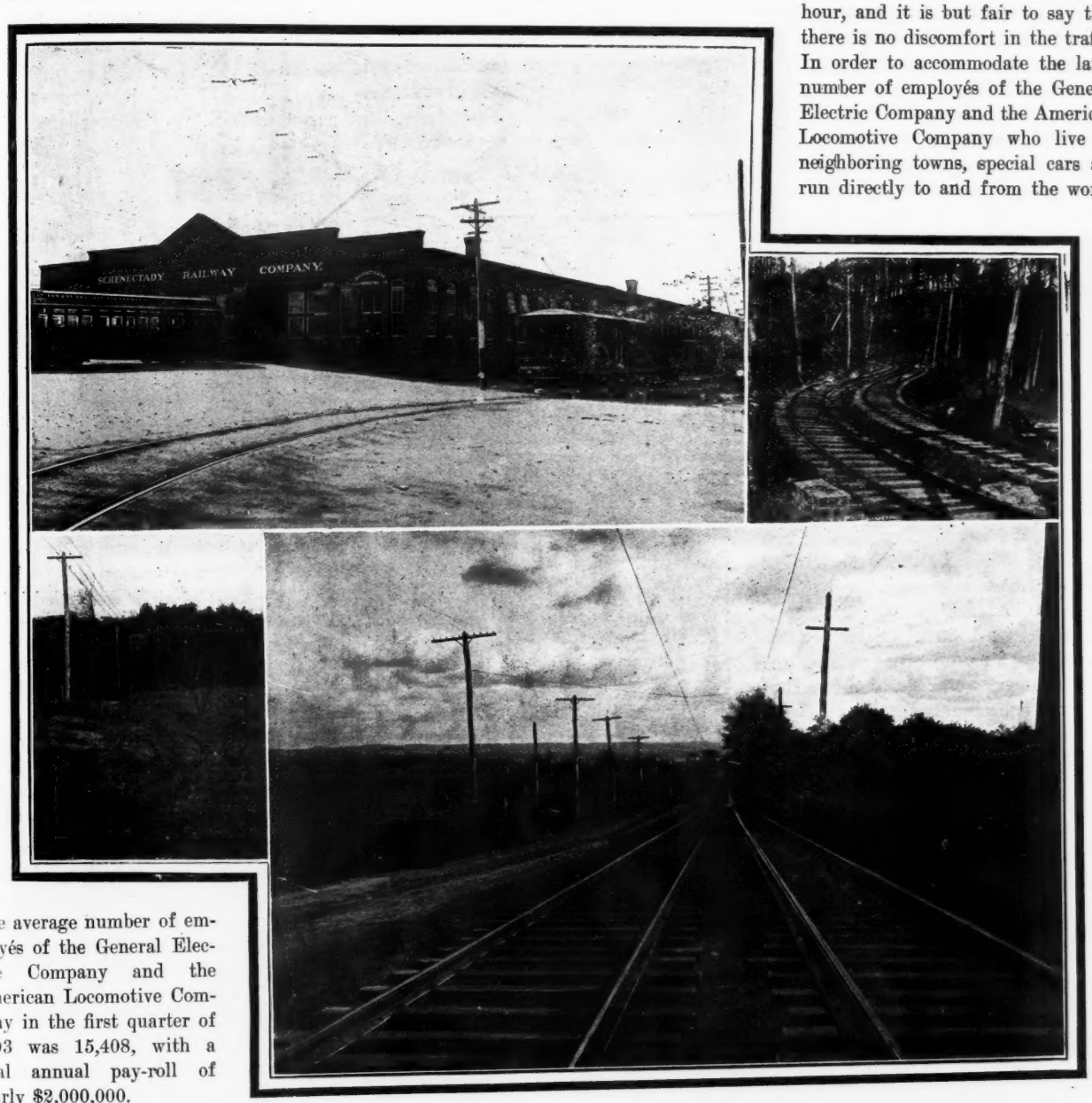
To sum up, the Schenectady Railway Company is operating at present over seventy-five miles of track, and has in course of construction about thirty-six additional miles; while its equipment has increased since 1894 to over 100 cars, handling during the year ended July 30, 1903, over 7,000,000 passengers. It seems remarkable that in 1894 the system consisted of two miles of single track, with an equipment of four closed cars, and at this period the company seriously considered the proposition of cutting down the service to three closed cars because of the lack of patronage. The extraordinary growth of the system may be attributed to the rapid increase in the population of the city of Schenectady, due to the development of the two large industries noted above—the General Electric Com-



THE SCHENECTADY RAILWAY COMPANY'S SYSTEM.

pany and the American Locomotive Company.

A fair idea of the increase in the population of the city may be gained from the following figures which have been taken from authoritative statistics: In 1880 there was a population of 13,655. In 1882 this was increased to 22,730; in 1890, to 31,682; and in 1902, to 53,000.



THE FULLER STREET CAR BARNS—A TURN ON THE TROY DIVISION, PRIVATE RIGHT OF WAY—A BIT OF THE HIGH-TENSION LINE—WHERE HIGH SPEED IS EASY.

The average number of employés of the General Electric Company and the American Locomotive Company in the first quarter of 1903 was 15,408, with a total annual pay-roll of nearly $2,000,000.

Union College, one of the oldest institutions of learning in the country, is situated at Schenectady.

Improvements in street construction are going on continually, and the city of Schenectady, while having passed through a boom which was in many ways similar to those witnessed in our western states, is still spreading, and a fine system of streets is being laid out and rapidly made up into first-class residential districts. The Schenectady Railway Company operates six lines in the city, under the following headway: State Street-Scotia Line, ten minutes; Bellevue-Aqueduct, seven and one-half minutes; Union Avenue Line, seven and one-half minutes; "A" Belt Line, five minutes; "B" Belt Line, five minutes; State Street Stub, fifteen minutes. These lines cover 22.66 miles within the city limits.

The handling of the large number of employés of the General Electric Company in the short space of time allowed before shop hours, and the inevitable haste with which the workers desire transportation home after business ceases, brought up a problem which presented many serious phases. By building a loop at the entrance of the works, with necessary storage tracks from which extra cars could be fed into the main line without interrupting the regular traffic, the company solved this problem successfully. In this manner 3,000 people are loaded and unloaded from the cars in less than half an hour, and it is but fair to say that there is no discomfort in the traffic. In order to accommodate the large number of employés of the General Electric Company and the American Locomotive Company who live in neighboring towns, special cars are run directly to and from the works over all interurban lines, both morning and evening.

The accompanying map of the Schenectady Railway Company's system will show the ramifications of the road and give a good idea of the city and interurban divisions.

Both the Troy and Albany divisions are

operated on a fifteen-minute headway from 9 A. M. to 8 P. M., and on a thirty-minute headway at other hours of the day. On the hour a special service has been established between Schenectady and Albany, called the Schenectady-Albany Limited. The trip is made in forty-five minutes, without stops outside of the city limits. For this special accommodation no extra fare is charged. A similar service will soon be put into effect on the Troy division. Round-trip tickets to Troy and Albany are sold at forty cents, and are interchangeable. A single fare is twenty-five cents. Commutation books containing fifty-two tickets, and limited to one month, are sold for $7.50.

As may be seen from the map, the line from Schenectady to Albany is practically a straight line. The track construction on this line approximates very closely to heavy steam railroad practice, and the riding is of the most satisfactory nature. The elimination of curves and the easy roll of the country allow a very high speed to be maintained on this division.

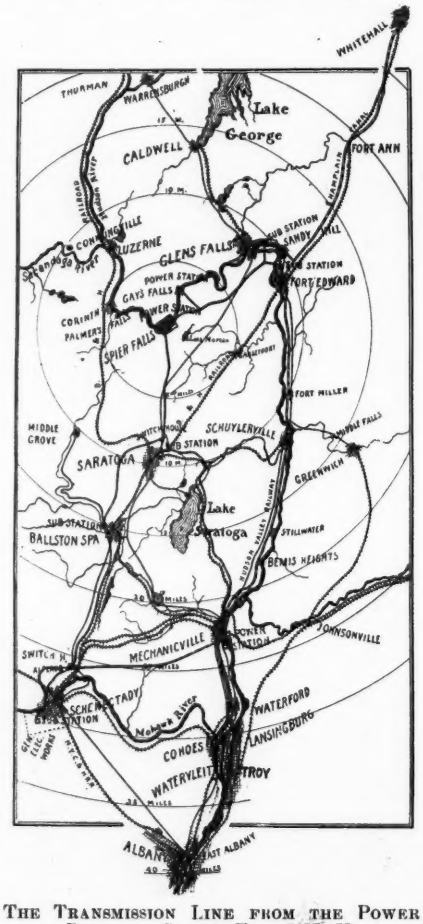
The road from Schenectady to Troy abounds in picturesque views of the surrounding country and passes through the celebrated Mohawk Valley, bringing into view the Helderberg Range, the Catskill Mountains, the Adirondack and Green Mountains, and the famous Mount McGregor, N. Y. For some distance the cars on the Troy division parallel the Mohawk River, while the division running from Schenectady to Aqueduct parallels the Mohawk River and the Erie Canal for the greater part of its length.

When the Ballston-Saratoga division has been completed, passengers will be taken from Albany and Troy, by means of a cutoff around the city of Schenectady, directly to Saratoga in about one hour.

The company is erecting near the Aqueduct, and just outside of the northerly limits of Schenectady, a double-track steel bridge having a total length of 1,769.53 feet. This is being built by the American Bridge Company, and is of the riveted lattice truss type, pin connected, resting upon ten concrete and masonry piers. This bridge will be forty-five feet above low water.

Plans have been made for a large terminal station in the centre of the city of Schenectady. The various executive offices of the company will be located in this station, and also the offices of the entire operating departments. Suites of offices will be rented in this building, and a commodious waiting-room will be established. The interurban cars, as well as some of the city local cars, will loop around this office building, enabling the Albany, Troy, Saratoga, Amsterdam, Johnstown and Gloversville passengers to be conveniently transferred to any car desired. This terminal station will be on lines of such magnitude as will make it not only a model, but the first of its kind erected in any of the eastern cities.

The rolling stock of the company is of the most modern type and is equipped throughout with apparatus manufactured by the General Electric Company. On the city system there are twenty-nine sin-



THE TRANSMISSION LINE FROM THE POWER PLANT AT SPIER'S FALLS, N. Y.

gle-truck closed cars, equipped with two G. E.-67 motors; eight single-truck closed cars, equipped with two G. E.-57 motors; four double-truck closed duplex cars, equipped with G. E.-52 motors; six eight-bench and twelve nine-bench single-truck open cars, equipped with G. E.-67 motors; twelve thirteen-bench double-truck open cars, equipped with G. E.-67 motors. On the interurban lines there are twelve forty-foot double-truck closed cars, equipped with G. E.-57 motors; ten forty-seven-foot double-truck closed cars with smoking compartments, equipped with G. E.-57 motors and G. E.-73 motors; six fifty-one-foot double-truck semi-convertible cars, equipped with G. E.-73 motors. In addition to this, there is a miscellaneous equipment of six motor flat cars, twenty-five dump cars, six express cars, three rotary snow plows, three small snow plows, one sprinkling car and one sand car. These cars were furnished by the St. Louis, Brill, Stephenson, Laconia and Jones car companies. The Brill semi-convertible cars are the most notable of the recent equipments. The interior of these cars is divided into two compartments separated by hardwood partitions having single sliding doors. The smoking compartment is eleven feet ten inches long, and the passenger compartment is twenty-seven feet ten inches long. Both compartments are finished in dull mahogany, handsomely carved, and with a ceiling of bird's-eye maple with gold strippings. The seats are upholstered in leather. The windows slide into the roof when not in use, and the cars are airy and well suited for summer service. The platforms have enclosed round-end vestibules sheathed with steel. The trucks are equipped with four G. E.-73 motors, and the G. E. type M system of train control is used. The interurban cars are all equipped with the Magann system of air brakes. A storage tank capable of holding 250 pounds of air is suspended below the car, and at all car houses and substations compressor outfits are arranged to supply a full charge of air in less than one minute. The Albany cars are fitted with the Flood system of emergency track shoe brakes, as this is considered necessary for extra precaution, because of the ten-per-cent grade on State street, Albany, just below the Capitol. The shoe is pick-shaped, and the wheel runs up on it and becomes locked, traction going on to the lower side of the pick.

A feature of the service on the Troy division is the placing of mail boxes on the front end of every car, so that any one along the route may stop the car to mail a letter.

On the city lines seven-inch and nine-inch girder rails of the Lorain Steel Company's section are used. The ties are firmly bedded in rock and concrete, with a concrete filling up to the tie; and from the curb line to about eighteen inches from the outside of the tracks, asphalt paving is laid. Between the asphalt and the track, and between the tracks, vitrified brick filling is used. This affords a construction which it is easy to keep clean, which facilitates drainage, and provides comfortable riding throughout the city limits.

The interurban tracks are laid with seventy-five-pound T-rails, thoroughly ballasted with either gravel or broken stone one foot under the ties, and filled up even with the rail. The tracks are well trenched, and careful attention has been paid to the drainage, several miles of six-inch tile having been laid alongside and between tracks.

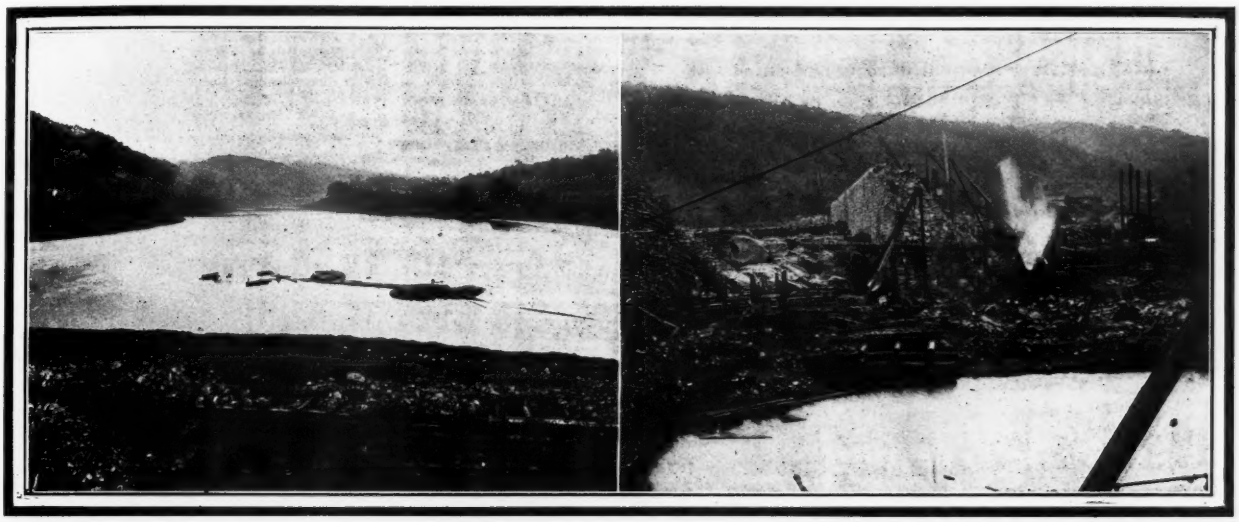
Section houses provided with hand cars and all necessary track tools are maintained at several points on the interurban lines, and the tracks are carefully inspected daily. Warning signals are provided at all danger points, and clusters of lights mark these spots at night.

In order that the passenger may not become confused as to his or her whereabouts either by day or night, all stations or stops along the lines are given numbers in consecutive order, and these are announced by the conductor.

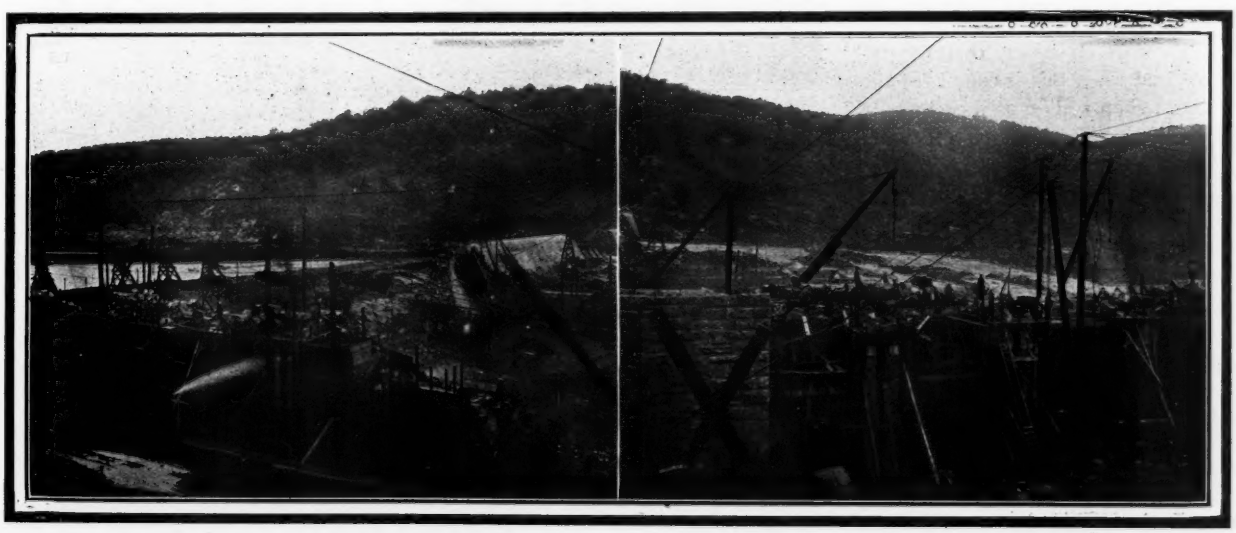
Span construction is used in the overhead work throughout the entire system, except on the Ballston division. For the city and interurban service thirty-five-foot and forty-foot chestnut poles, set 100 feet apart, are used. On the Ballston division thirty-five-foot octagonal yellow pine poles, embedded in concrete, are used in connection with the centre-pole double-bracket construction. The tracks on the Ballston division are on thirteen-foot centres, and the roadbed is graded twenty-nine feet. On the interurban lines 0000 grooved trolley wire is used, and on the city lines, 000 grooved wire.

A number of bridges have been necessary on this system. One at the Scotia crossing of the Mohawk River contains eight spans of the pony truss type, the total length of the bridge being 773 feet, of which 396 feet are laid with single track and 372 feet with double track, there being a siding on the bridge. On the Troy division there is a steel trestle 203 feet long, with an average height of six-teen and one-half feet. On the Aqueduct line there is a pony lattice bridge 103 feet long, with an average height of twenty-six and one-half feet.

The car houses have been erected on Fuller street and on McClellan street, Schenectady, the latter having been but recently built. This building is 300 feet long by 116 feet wide, and is of brick with steel truss roof. Eight tracks are provided, and each entrance is closed with a Kinnear rolling door. In the centre, four tracks have pits seventy-five feet long, and



SPIER'S FALLS, N. Y.—RESERVOIR FROM TOP OF INCOMPLETED DAM. SECTION OF COMPLETED DAM FROM RACE WALL, HUDSON RIVER WATER POWER COMPANY.

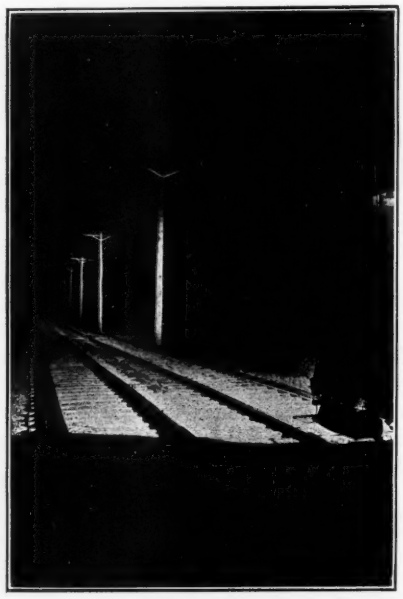


SPIER'S FALLS, N. Y.—DAM AND RACE LOOKING OVER SIDE OF POWER STATION. HEAD RACE AND FLUMES, HUDSON RIVER WATER POWER COMPANY.

at one side there are tracks having pits seventy-five feet long. One section of the building is partitioned off for a blacksmith and machine shop seventeen feet wide by forty-two feet long, and one of the tracks extends through this shop. Included in the equipment of this shop is a twenty-one-inch Barnes drill press, a Buffalo forge, a No. 3 Challenge tool grinder, and a four-ton Harrington hoist, together with all necessary equipment for handling light repairs. The building has a wing twenty-one feet long by sixteen feet wide. The front portion is used for the receiver's room. The centre room is for employés and is provided with individual lockers extending entirely around the sides of the room, and opening from this is a large toilet room. In the rear is a stockroom and office for the storekeeper, with a separate room for the shop employés. One entire side of the Fuller street building is utilized for freight and express business. This is equipped with double doors and has a track at the side of the house. The other side of the house is utilized for the main repair shop. The equipment includes a 100-ton forty-inch by nine-inch Niles wheel press, a thirty-six-inch by sixteen-inch Fitchburg wheel lathe, a thirty-six-inch Niles boring mill, an eighteen-inch by eight-inch Reed lathe, a twenty-one-inch Barnes drill press, a Yankee drill grinder, a four-foot by four-foot Buffalo forge, a No. 4 Challenge tool grinder, two Patten motor lifts, and a five-ton seventeen-foot-span Morris crane.

Plans have been completed and work will shortly start on a very complete repair shop, and when this is completed the Fuller street shop will be used exclusively for a car house. The building will be in three sections, the outside measurements being 201 feet by 210 feet 4 inches. First section will include armature room, machine and blacksmith shops. Adjoining it will be an erecting room which will have 300 feet of pits. The centre section will have two floors. The front is to be utilized for offices for the various departments, and the balance of the section will be utilized for storerooms. The first floor has a steam road track running through it. In front there is a team entrance provided with a platform scale. In the rear will be a large storeyard for rails, ties, special work and other large material. The third portion of the building will have three tracks and will be divided in the centre, the front being for the paint shop and the rear for carpenter shop. In addition to the machinery already owned, which will be centralized here, the company will purchase two fifteen-ton hand-operated cranes, a power rail bender, a motor flat car equipped with an electrically driven crane of five tons capacity, shapers, planers, boring mills and other machine shop equipment. The pits will be open, provided with concrete piers, and will have tracks provided with hydraulic jacks.

A well-equipped emergency house is established in Schenectady, near the centre of distribution of the system. This emergency department is equipped with tower wagons provided with hose crossings, tools and wire. The house is arranged similar to a fire engine house, and is connected with the automatic fire-alarm system. The wagons respond to calls in all districts covered by the electric light-



NIGHT SCENE ON THE TROY DIVISION, SCHENECTADY (N. Y.) RAILWAY.

ing and railway system, and a number of men are kept in constant attendance.

An extensive freight and express business has been developed, and carries on practically all the through business between Albany and Schenectady. Arrangements will soon be made for a similar service on the Troy and other divisions. The freight and express business is conducted by the Electric Express Company, which maintains a distinct organization. Freight stations have been established in both Schenectady and Albany, the latter being in connection with the station of the United Traction Company. The business is divided into three classes. Class A provides wagon service at both ends, handled at thirty cents per hundredweight; Class B, goods which are not handled at either end, ten cents; and Class C, goods which require wagon service at one end only, at fifteen cents. The company maintains three single and three double teams in Schenectady, and one double team and two single teams in Albany. The express cars make four round trips per day, and have a running time between cities of one hour and fifteen minutes. These cars are equipped so that they may be run two or more together, with multiple unit control. The road handles no free baggage. The express company calls for trunks in either of the cities and delivers them in the other at forty cents each. A large amount of trucking was formerly done between the two cities, but the electric line has eliminated this entirely. About four-fifths of the business is made up of incoming goods purchased by the Schenectady merchants. The following figures show the average carrying service done by the company: In May there were 1,272,173 pounds incoming and 366,587 pounds outgoing. In June there were 1,431,444 pounds incoming, with 315,901 pounds outgoing.

All the car-card advertising on the system is handled by the company, a charge of $7.50 per month being made.

A large tract of land at the east end of Ballston Lake, on the new branch, has been purchased, and plans are under way for an elaborate summer park. There will be a large casino, dance hall, pavilion, toboggan slide, carousel, baseball park, trotting track and a number of other features. Brandwine Park, Schenectady, is operated by the company, and is let out for picnics. This park contains a pavilion, refreshment stands and other buildings.

A feature of the trafficking department is the advertising of "Twilight Trolley Tours." Special cars leave the city station each evening and run for twelve miles, returning over one of the interurban divisions. The cars are decorated with colored incandescent lights, and have a shield, star or crescent on the front dash. These ornaments are wired with a single terminal, and the cars are used in the regular service during the day. A charge of twenty-five cents is made for the ride, and the load is limited to the seating capacity of the thirteen-bench open cars.

The power used for operating the Schenectady railway is furnished mainly by the Hudson River Water Power Company from its large water power plant at Mechanicsville, augmented at times by the steam plant of the General Electric Company. The power is transmitted from Mechanicsville at a voltage of 10,000 and a frequency of forty cycles over two entirely different routes. One

THE INTERIOR AND EXTERIOR OF THE TROY SUBSTATION, AND ONE OF THE CARS, TROY DIVISION, SCHENECTADY RAILWAY.

of these transmission lines crosses the country about in a straight line from Mechanicsville to the General Electric works at Schenectady, touching Alplaus and crossing the Mohawk River at the Scotia bridge. This is the main line and consists of three No. 000 B. & S. bare copper wires mounted on double petticoat porcelain insulators. The power transmitted over this line is used to supply the wants of both the General Electric Company and the Schenectady Railway Company. The power used by the railway company in its Dock street substation is conducted by two No. 1 B. & S. three-conductor cables, one being used exclusively for the railway load and the other for lighting the city, being transformed to 2,300 volts for the lighting circuits.

The second transmission line starting from Mechanicsville passes along the Erie Canal through Watervliet, where it turns and following the line of the Schenectady Railway Company's Troy division tracks enters the Troy substation, located at Lathams Corners. From here three No. 2 B. & S. wires follow across country to the Albany substation, located at Karner on the line of the company's Albany division. Duplicate lines then follow the tracks located on the Albany-Schenectady turnpike into Schenectady to the General Electric works, thus making almost a circle

from Mechanicsville around through the substations and the General Electric works back to Mechanicsville. When the new Dock street substation is completed these transmission lines will be changed somewhat. The lines from the Albany substation will be rebuilt to consist of duplicate aerial lines of No. 1 B. & S. bare copper from the Albany substation to the city limits. The current will then pass underground through duplicate paper-insulated cables, each consisting of three No. 1 B. & S. stranded wires made into a cable, to the new Dock street station, instead of going direct to the General Electric works. The connection between the new Dock street station and the General Electric power-house will be by three three-conductor No. 000 B. & S. cables placed in duct in the street. The line from the General Electric works to Mechanicsville will remain unchanged.

The Hudson River Water Power Company will furnish power from another source, *i. e.*, Spier's Falls, situated approximately forty miles from Schenectady, over a transmission line direct to the power-house of the General Electric Company. The voltage of this line will eventually be 30,000.

Another steam source for supplying power to the railway company besides the present power-house of the General Electric Company will be the large steam turbine station now being built by the General Electric Company. This station will contain at present three 1,500-kilowatt Curtis steam turbine sets and will use Stirling boilers and electric auxiliaries. The station is designed, however, for a much larger capacity.

The old steam power-house of the Schenectady Railway Company, on Dock street, is a one-story building, having a frontage on Dock street of seventy-four feet and extending 119 feet toward the tracks of the New York Central & Hudson River Railroad Company. The station is divided longitudinally by a party-wall into a boiler room on the south side and an engine and dynamo room on the north side. The use of steam has been discontinued, although the machinery has not been dismantled. The boiler room contains one Stirling and three Babcock & Wilcox boilers aggregating about 1,030 horse-power, while the engine equipment consists of one Erie simple and two vertical Westinghouse compound engines; one Ball & Wood engine having been sold recently. The railway machinery at present operating in the station consists of three rotary converters made by the General Electric Company, each of 300-kilowatt capacity at 760 revolutions per minute. There is also one 200-kilowatt, 800 revolutions per minute, compound-wound, General Electric rotary converter. The 10,000-volt, forty-cycle, three-phase current from Mechanicsville is fed into the three 300-kilowatt rotary converters through nine static transformers of the air-blast type, each of 110-kilowatt capacity and which transforms the voltage from 10,000 to 372.

The 200-kilowatt rotary converter is fed through a 225-kilowatt, three-phase, air-blast transformer. All of these transformers are provided with additional leads connected to the middle points of the secondary windings, in order that the rotary converters may be started from the alternating-current side at half voltage, thus cutting down the starting current.

The railway switchboards are of the standard General Electric type for such installations, and are of black enameled slate, provided with the usual circuit-breakers, ammeters, knife blade switches, etc. One of the panels is provided with a total Thomson recording wattmeter. The 10,000-volt operating switchboard is placed in a gallery above the low-tension boards, and is equipped with oil switches, ammeters, etc.

The Troy substation of the railway company is located at the intersection of the Loudonville road and the Troy-Schenectady turnpike. The lot covers an area of 3.22 acres. The building is one story and cellar, twenty-six feet by seventy feet. The station is built of brick and is thoroughly fireproof in construction. The floor is of concrete with a granolithic top. The apparatus consists of three 300-kilowatt rotary converters operating at 760 revolutions per minute. The transformers are of the three-phase, air-blast type and are two in number, each of 330-kilowatt capacity. Each converter is also provided with a reactive coil in the alternating-current side for the purpose of regulating the voltage. Part of the cellar is made into an air-blast chamber for the transformers, while in the other part of the cellar the cablework and wiring is carried on insulators fastened to the walls and converter foundations. The switchboard is of black enameled slate and is made up of three direct-current feeder panels, two direct-current rotary panels, two alternating-current rotary panels and three 10,000-volt panels. The low-tension panels are all of the General Electric standard pattern, provided with circuit-breakers, ammeters, etc.

The 10,000-volt panels are provided with single-pole, oil-break switches, mounted in separate brick cells, about ten feet back of the panels themselves. The switches are provided with overload relays, and in the panels themselves are mounted horizontal, edgewise, black oxidized ammeters, voltmeters, power-factor indicators, and one round pattern, induction, recording wattmeter. The bus-bars back of the panels are heavily insulated and carried on an insulated iron framework. All of the 10,000-volt feeders enter the station overhead and are connected with a suitable number of lightning arresters of the Wirt type. At this station there is also an air compressor for use in connection with the Magann air storage system. This air compressor is operated by a belted twenty-horse-power induction motor.

The Albany substation is a one-story frame structure with cellar, is forty-five feet square. The lot on which it stands is 75 feet by 100 feet. The description of the Troy substation applies directly to that of the Albany substation.

The Ballston substation is in process of construction and is intended to furnish current for the operation of the Ballston division of the railway company. The following apparatus is in process of manufacture by the General Electric Company: Three 300-kilowatt, forty-cycle, compound-wound rotary converters running at 800 revolutions per minute; three air-blast, 220-kilowatt transformers provided with double secondary windings; one blower set, consisting of a two-horse-power, three-phase, induction motor, direct-coupled to a thirty-five-inch Buffalo forge fan; two forty-five-kilovolt-ampere, air-blast, reactive coils; one twenty-horse-power, three-phase induction motor with two pulleys for operating a Magann compressor and the necessary switchboard panels for the above apparatus.

The property on which the new Dock street substation is built has a frontage on Dock street of 180 feet, while the distance on the rear next to the New York Central & Hudson River Railroad Company's tracks is 368 feet. The depth of the lot is 165 feet. The new substation is 165 feet eight inches front by forty-five feet two inches deep, and is of brick and steel construction, thoroughly fireproof throughout. The station is without a cellar for the reason that at times of freshets water from the Mohawk River and Erie Canal overflows and would in all likelihood flood the cellar. The outside walls of the basement are faced with brownstone and the basement itself is divided off by means of brick partition walls

into air-blast chambers, bus-bar compartments and oil-switch cells.

On the first floor will be located all of the transforming apparatus, and this floor is of steel and concrete construction.

The railway apparatus to be placed in this substation consists of two 600-kilowatt, 600-volt, six-phase, forty-cycle rotary converters, together with two ninety-kilovolt-ampere air-blast, static transformers. Two 300-kilowatt, 600-volt, three-phase, forty-cycle rotary converters, and two forty-five-kilovolt-ampere, air-blast, reactive coils, and six 110-kilowatt, 10,000-volt, primary, forty-cycle, air-blast transformers, space being left for a future 600-kilowatt rotary converter.

All of the 10,000-volt bus-bars, etc., are placed in the basement between brick and concrete barriers, and each phase is thoroughly insulated. The transmission and primary lines leading to the various transformers are operated by means of oil switches, electrically operated, these switches being placed in brick cells. The switchboard panels are placed on the opposite side of the station from the switches and the operating voltage is reduced by means of potential and current transformers so that at the switchboard panels it will not be greater than 150 volts. The current for operating the oil switches is furnished by means of a storage battery, built by the Electric Storage Battery Company, of Philadelphia, Pa., and consists of fifty-five cells. The 10,000-volt bus-bars are arranged so that they can be sectionalized by means of knife-disconnecting switches. All of the switchboard panels are of black enameled slate and the instruments have the marine finish. Each of the three-phase incoming line panels has a capacity of 4,000 kilowatts at 10,000 volts, and each panel contains the following apparatus:

One horizontal, edgewise ammeter; one horizontal, edgewise voltmeter; one double-pull, overload relay with lamp for indicating the open and closed position of the oil switches; one controlling switch for oil switches, together with the necessary current and potential transformers and static dischargers.

There are two three-phase, outgoing line panels with a capacity of 1,500 kilowatts at 10,000 volts, and each panel contains one horizontal edgewise ammeter, one polyphase, induction, recording wattmeter (railway pattern), together with relays, controlling switches, indicating lamps and current transformers and static dischargers.

Each of the three-phase, rotary converter panels is equipped with a power-factor indicator and horizontal, edgewise ammeter and a three-phase induction recording wattmeter, together with overload relay, controlling switches for the oil switch, indicating lamps and secondary transformers.

The lighting of the Dock street powerhouse has been worked out with a view of providing against any possible failure of current. The ordinary lighting will consist of twenty-four arc lamps, placed on brackets fastened to the sides of the wall and lighted by means of current from the ordinary lighting circuits of the company. As an emergency lighting a number of incandescent lamps will be mounted on the roof girders and will be fed from the railway circuit. Should both the railway and lighting fail, arrangements have been made for placing a number of lights on the storage battery. The station will be provided with a traveling crane having a capacity of fifteen tons and will be arranged in such a manner that the track for this crane extends outside of the building under an archway so that teams driving under this archway may be unloaded directly by the crane.

The Schenectady Railway Company, in addition to the express company, also operates the lighting and gas companies. The installed load of the lighting company amounts to an equivalent of 84,000 sixteen-candle-power lamps, while the motors for three-phase current number 4,556. A great deal of this lighting is used for stores and signs, but over fifty per cent of the light is used for domestic purposes. This fact, and the great number of meters installed in proportion to the population, is one of the features of the lighting system. The lighting company also furnishes current for lighting the street lamps of the city, the series alternating tub transformer system with enclosed arc lamps being used. Current is obtained from Spier's Falls, Mechanicsville and the General Electric Company, similar to the arrangement for the railway current, and is supplied to the Dock street substation at Schenectady. The apparatus at present consists of motor-generator sets and static transformers. Owing to the lack of capacity, three feeders are run on forty cycles, but the intention is ultimately, when the new Dock street station is completed, to furnish sixty cycles throughout. The new Dock street station will contain three 500 and three 250-kilowatt motor-generator sets, and will be a model in every respect, using the most up-to-date switching and other apparatus. The distribution system in the centre of the city will be mostly underground, ducts being made for this purpose, and the cable now being in process of construction. The system consists of sixty-cycle, single-phase, 2,300-volt primaries with manholes and subway transformers and a system of three-wire secondary mains. The underground cables will be run through the business portions of the city, and the outlying portions will be supplied by overhead feeders. The system of three-wire secondaries and banked transformers is used wherever convenient, individual transformers being used only in isolated cases.

A contract has just been obtained from the city of Schenectady for furnishing apparatus, pumps, motors, etc., and tower for pumping water used for public purposes. This plant will consist of vertical high-head turbine centrifugal pumps, and will have a capacity of 12,000,000 gallons daily. The pumps will be direct-connected to 800-horse-power, forty-cycle induction motors. This will be one of the first installations of its kind in the world, and will be unique in type; and it is proposed to make a model in design and construction. By a recent purchase of the Mohawk Gas Company's plant, the railway company has added another division to its properties. Extensive plans have been laid to rebuild and add to the local plant, and some of the work is already completed. The maximum capacity of the generating plant will be 1,750,000 cubic feet. The company is now serving 3,500 customers, sixty per cent of these using prepayment meters. Both coal and water gas is manufactured.

The company maintains a very complete system of records and accounts. The general manager has before him at all times tabulated statements of the equipment and general condition of the system, and these are brought up to date at frequent intervals. All operating expenses and receipts are figured on a basis of eighteen-hour cars per day, and each item of expense is charged to its proper account. A detailed statement for each month, together with some statements obtained from well-known roads employing the same system, is posted for comparative purposes in the office of the general manager. An examination of the operating expense sheet for the month of May, 1903, gives the receipts per eighteen-hour car as $51.62. This is claimed to be higher than the receipts of any other similar proposition in the country. The operating expenses are given as 60.9 per cent of the gross receipts. These figures do not include the lighting business or the express business, as these are operated as distinct organizations.

The discipline and spirit of the employés are excellent, and the extremely liberal treatment of the employés by the company has brought about a condition of affairs which is a high tribute to the executive and operating departments. Promotion is by order of seniority, the men starting extra on the city cars and moving up to regular cars; then extra on local interurban cars, and

finally to regular service on a limited interurban car. All employés are allowed ten days' vacation with full pay, after one year's service. The superintendent keeps a card index system, and a record of each man is placed in a filing case, together with application, medical examination and reports relative to his work. There are three ways of action in case of infraction of rules—first, by inspector; second, by letter; third, a call before the superintendent. The latter action is seldom taken. The first failure to report on time calls for a suspension of two days; if repeated again within six months, a suspension of five days. For the third time within six months the employé is called before the inspector for trial.

At the Fuller street car house an entire floor has recently been added and fitted up with a remarkably complete club room for the emplovés. The four front rooms are utilized for the office of the master mechanic, the company's physician, the express manager, and the office of the benefit association. The club rooms include a billiard and pool room, a locker room, washroom with bathtubs and shower baths, two bowling alleys with platform for spectators, and a reading room, as well as an assembly room with platform and stage. The partitions between the reading room and the assembly room are vertical sliding doors, so that the rooms can be thrown together for large gatherings. The dues of the association are fifty cents a month, which is deducted from the pay of the men each month. The constitution provides that if the fund is not sufficient to meet the obligations, the board of trustees shall have the right to assess each member not to exceed an additional fifty cents per month. Disability by reason of accident or sickness insures a member an income of $1 per day for a period not exceeding ninety days. The death of a member provides an insurance of $150. The management of the association is vested in a chairman and six members. The chairman is always an officer of the Schenectady Railway Company, who appoints three members of the board of trustees, the other three being elected by a majority vote. These club rooms are so arranged that they present at all times a most inviting prospect to the employé with time on his hands, and are well worthy of inspection and study by any one interested in economic conditions.

The officers of the company are: Hinsdill Parsons, president; E. F. Peck, general manager; James O. Carr, secretary-treasurer; J. J. Magilton, auditor and assistant treasurer; C. C. Lewis, chief engineer; F. G. Sykes, electrical engineer; C. F. Coffin, manager gas department; E. J. Ryon, manager express department; Frederic Smith, superintendent; J. H. Aitkin, purchasing agent. Directors: Hinsdill Parsons, E. F. Peck, E. W. Rice, Jr., G. E. Emmons, F. O. Blackwell, H. C. Wirt, J. R. Lovejoy, A. L. Rohrer, W. L. K. Emmett.

Refining Lead Bullion by Electrolysis.

At a recent meeting of the American Institute of Mining Engineers, Anson G. Betts described a new method of refining lead by electrolysis. A solution of lead fluosilicate containing an excess of fluosilicic acid has been found to work satisfactorily as an electrolyte for refining lead. It conducts current well, is easily handled and stirred, is non-volatile and stable under electrolysis. It may be made to contain a considerable amount of dissolved lead, and is easily prepared from inexpensive materials. It possesses, however, in common with other lead electrolytes, the effect of yielding a deposit of lead lacking in solidity which grows in crystalline branches toward the anodes, causing short-circuits. But if a reducing action, practically accomplished by the addition of gelatine or glue, be given to the solution, a perfectly solid and dense deposit is obtained, having very nearly the same structure as electrolytically deposited copper, and a specific gravity of about 11.36 that of cast lead.

A neutral solution of lead fluosilicate is partially decomposed on heating, but this decomposition ends when the solution contains about two per cent of free acid. The solutions desired for refining are not liable to this decomposition, since they contain much more than two per cent of free acid. The electrical conductivity depends mainly on the acidity of the solution. The first experiments were carried out without the addition of gelatine to the solution. The lead deposit consisted of more or less separate crystals. The cathodes, which were sheet-iron plates, lead-plated and paraffined, had to be removed periodically from the tanks and passed through rolls to pack down the lead. When gelatine has been added in small quantities, the density of the lead is greater than can be produced by rolling the crystalline deposits, unless great pressure is used.

As a starting material, hydrofluoric acid of thirty-five per cent is used. This is run by gravity through a series of tanks. In the top tank is a layer of quartz two feet thick, in passing through which the hydrofluoric acid dissolves the silica, forming fluorsilicic acid. White lead in the required quantity is added in the next tank, where it dissolves readily and completely, with effervescence. All sulphuric acid and any hydrofluoric acid that may not have reacted with the silica precipitate out in combination with lead. The lead solution is then filtered and run by gravity into the refining tanks.

The anodes may contain any or all of the elements. Gold, silver, copper, antimony, arsenic and bismuth, being more electro-negative than lead, should remain in the slime in a metallic state, with perhaps tin; while zinc, nickel and cobalt should dissolve. Iron dissolves only slightly. This process completely removes bismuth and antimony, and the small amount of tin—from 0.02 to 0.03 per cent—is easily removed by poling.

The electrolyte takes up no impurities, except possibly a small part of iron and zinc. It may be purified in several ways. For example, the lead may be removed by precipitation with sulphuric acid, and the fluorsilicic acid precipitated with salt. By distillation of the sulphuric acid the fluosilicic acid may be recovered. The only danger of lead poisoning to which the workmen are exposed occurs in melting the lead and casting it.

This process is being used by the Canadian Smelting Works, at Trail, British Columbia. There are twenty-eight refining tanks, each eighty-six inches long, thirty inches wide and forty-two inches deep, each receiving twenty-two anodes of lead bullion, with an area of twenty-six by thirty-two inches exposed to the electrolyte on each side. The total weight of anodes in each tank is three tons, and they dissolve in from eight to ten days. Each tank contains twenty-three cathodes of sheet lead, prepared by depositing lead on paraffined iron cathodes.

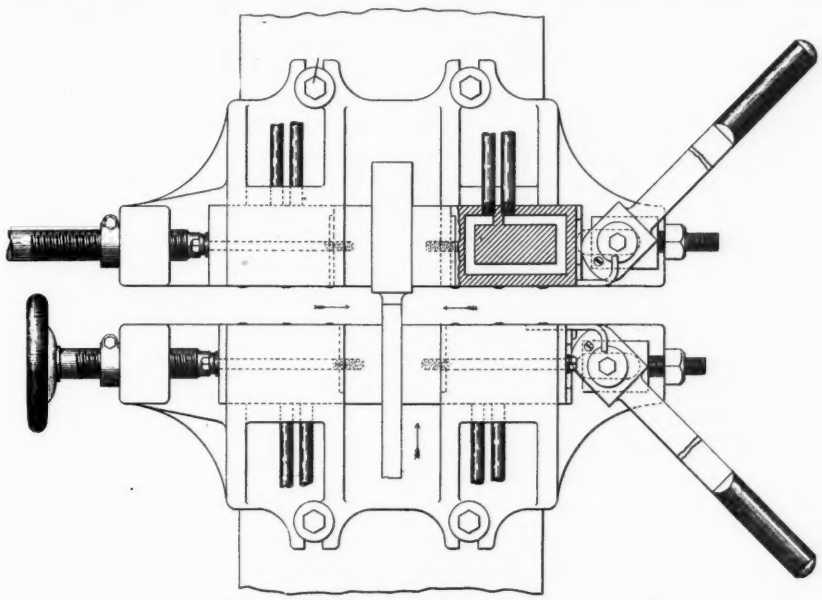
Each tank is capable of yielding, with a current of 4,000 amperes, 750 pounds of refined lead per day. In addition to the ohmic resistance, there is a counter-electromotive force of about 0.02 of a volt per tank to be overcome. The tanks are made of two-inch cedar, bolted together and thoroughly painted with rubber paint.

The Journal of the Franklin Institute.

The August issue of the *Journal* of the Franklin Institute contains an article by C. E. Farrington, entitled "Defective Machine Insulation." This discusses the defects of various kinds of insulating materials and their desirable qualities. There are, in addition, the following papers: "Safety Mining Lamps," by Rufus J. Foster; "The Utilization of Blast Furnace Gases for Power Purposes," by Charles Kirchhoff; "On Convergents and Arithmetical Series, the Ratio of Whose Terms Approximates Successively the Value of π, and on Their Application to the Construction of Computing Machines," by F. L. O. Wadsworth; "Fuel Oil," by John F. Rowland, Jr., and "The Census of Manufactures of 1900," by Charles E. Munroe (concluded).

Electrical Patents.

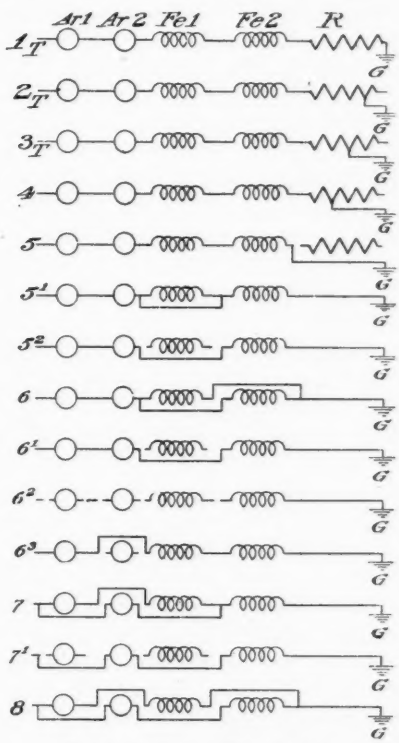
The Thomson Electric Welding Company, of Lynn, Mass., has recently been granted, as assignee, a patent on a clamping device for electric metal-working apparatus, which is the invention of Adolph F. Rietzel, also of Lynn, Mass.



Clamping Device for Electric Metal-Working Apparatus.

The invention is designed more particularly to improve the construction and operation of the clamping devices employed for electric welding machines, although it may be also employed on machines organized or adapted for use in carrying on other kinds of metal-working operations. The successful operation of electric welding machines depends almost wholly upon the construction of the clamping devices which have to be adapted for various kinds of work and which must, moreover, be capable of holding the work tightly and be so constructed that the work may be quickly put in and taken from the clamps. They must also be strong enough to hold the work firmly in the jaws without slipping when the pressure is applied to complete the weld or perform other operations when the metal has been softened by the current to the required degree. One of the principal objects of this invention is to provide clamping devices especially suited for use with heavy work and readily adjustable for different classes or kinds of work. The invention may be employed, for clamping flat stock, straight pieces, angle work, round stock, or other material to be welded or otherwise worked when electrically heated. Another object of the invention is to provide for the application of a clamping pressure to a very considerable portion of the pieces to be welded or worked, so as to provide large areas through which current may be fed to the work, while at the same time giving ready access to the clamping devices and permitting the work to be readily inserted or withdrawn. Another object is to bring the line of clamping pressure upon the work as near as possible to the line of heating or welding. In the preferred manner of carrying out the invention the two clamping jaws which hold the work are mounted at one side of the line of heating in such a manner that the pressure shall be applied in a horizontal line or line substantially parallel to the bed of the machine, thus leaving the opening between the jaws free or clear from above. With one of the jaws is combined a suitable adjustable screw which is set or adjusted for different sizes of work, and with the other jaw is combined a cam lever which is manipulated during the operation of the machine for carrying on a certain class of work or work of a certain size with reference to which the opposite jaw is adjusted by means of a screw, the latter adjustment being practically a slow or fixed adjustment and the former or that which is carried on by means of the cam being the temporary or quick adjustment used in clamping and unclamping the work. Another feature of the invention relates to means for setting or adjusting the jaw for different classes of work and for at the same time providing a means whereby the jaw may be secured to the jaw-carrying slide and may be readily removed to permit the substitution of jaws adapted for different kinds or forms of work.

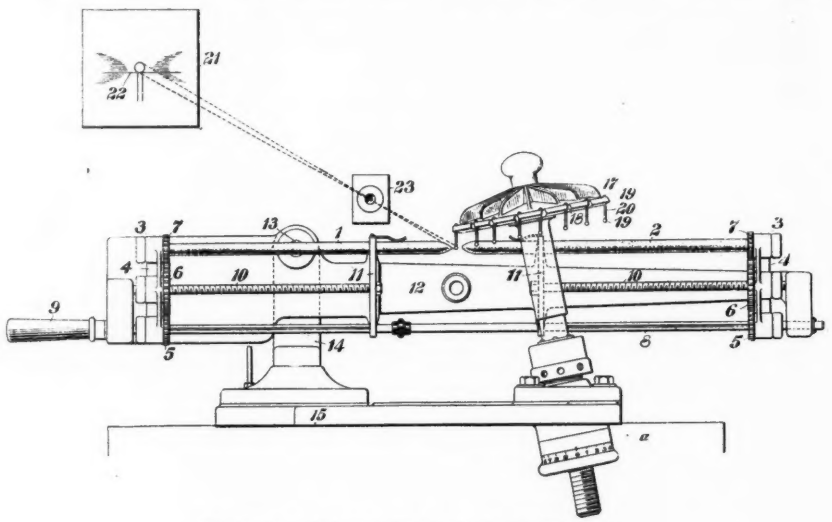
Frank A. Merrick, of Johnstown, Pa., has devised and patented means for controlling electric motors and the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., has obtained control of this patent. The invention is designed to provide an improved method of changing a pair of motors from series to parallel relations without the use of wasteful external resistance and by a series of steps which provides a nearly uniform acceleration in their speed, and which avoids undesirable circuit conditions. The invention more particularly relates to a system of motor control in which motors are changed from series to parallel relation by first connecting their fields only in parallel, then shifting them to a relation in which one of the motors



Electric Motor Controller.

is shunted by the armature of the other motor whose field is in series with the first motor, and then finally connecting the two motors in parallel. In changing from the relation of parallel fields and series armatures to a relation in which one motor is shunted by the armature of the other motor it is of course necessary to change the armatures from series to parallel relation and the fields from parallel to series relation at a time when the motors are carrying considerable current and have attained considerable speed. The simplest and most obvious method of making this change is to open entirely the circuits through the motors and then recircuit them in the desired re-

lations. There is no objection to this provided that the period of open circuit is sufficiently brief not to affect the speed or counter-electromotive force of the motors. This, however, has not heretofore been possible in practice for the reason that if the controller be moved rapidly across the open-circuit position the arcs which form between the controller contacts and fingers on leaving the preceding position are apt to be maintained across the open-circuit point until the succeeding position is reached. The effect of this, as will be readily seen, is in a measure to superimpose one circuit condition upon another in a manner likely to result in serious confusion of circuits and very probably give a short-circuit from trolley to ground. This is more apt to occur during the backward movement of the controller from the position of parallel armatures to a position of parallel fields, the arcs in the controller tending to maintain the series position of the fields up to the time that the proper contacts in the controller are engaged to effect a multiple connection of the fields, in which case there can result a direct short-circuit from trolley to ground. Consequently, in order to avoid results of this character it has been necessary to make the points of open circuit sufficiently wide on the controller drum to ensure the extinguishment of all arcs in the controller while moving across this position. This, however, leaves the circuit open for a period sufficiently long to affect the speed and especially under the condition of a heavy load, and the effect upon the car is noticeable. The present invention is more particularly designed to provide a method of control in which the effect of opening the circuit in passing from the position of parallel fields to parallel armatures or the reverse is practically eliminated in so far as any objectionable confusion of circuits or effect upon the car is concerned. With this and the previously stated objects in view, the invention, broadly considered, consists in the method of carrying a pair of motors across an open-circuit position on the controller by making the period of open circuit of brief duration and preceding and following such position in both directions of movement of the controller by circuit relations of the motors or motor elements of such character as to avoid short-circuits and other undesirable circuit conditions which might otherwise result by reason of the fact that arcs formed between the controller fingers and contacts might be maintained across the open-circuit position, and thus tend to superimpose one set of circuit connections maintained through such arcs upon another set established by the controller contacts, such preceding and following circuit relations being, furthermore, such that the conditions which may result from such a superimposition of connections will by their nature and in view of the resistance of the maintained arcs be to a certain extent beneficial. More especially considered the invention consists in the employment of the above described method in changing a pair of motors from a relation in which their fields are in parallel with each other and in series with their series-connected armatures to a relation in which the armature of one motor is in parallel with the other motor with its own field in series with that motor; and in doing this the open-circuit position is preferably preceded by a circuit condition in which both armatures and one field are in series, with the other field open circuited. In the reverse movement of the controller the open-circuit position is preceded by a circuit relation in which one armature and both fields are in series and the other armature is open circuited.



METHOD OF MAKING ELECTRIC LAMP GLOWERS.

A new method of and machine for making electric lamp glowers of the type in which the glowers are non-conductors when cold and become conductors when heated, has been invented by Marshall W. Hanks, of Pittsburg, Pa., the well-known expert in this line, and George Westinghouse has purchased the patent. The object of the invention is to provide an improvement in the art which will cheapen the cost of production of glowers and render it feasible easily and expeditiously to make any number of glowers of any given length in order to adapt them to a given voltage. It has been the usual practice in the manufacture of glowers to form a rod or string of suitable length and of the desired diameter, then cut such rod or string into suitable sections or lengths, then fuse each end of each of the blanks by means of an electric arc to form a bead, and finally attach terminal wires to the beads by embedding the ends of the wires in the beads or otherwise. It is, of course, essential that all glowers intended for use in connection with a given voltage should be of substantially the same diameter and the same length. It has been the practice, therefore, after having formed a bead upon one end of the glower to hold the other end in the arc by means of suitable tweezers and to remove the glower from the arc for the purpose of measuring it. It will be readily understood that several removals of the glower from the arc may occur before the desired length has been reached. In order to avoid the loss of time incident to the operation above specified and at the same time ensure an exact uniformity in the length of the glowers, Mr. Hanks has devised the following machine and method: As illustrated in the accompanying illustration, 1 and 2 are carbon rods or pencils which are included in an electric circuit and between the adjacent ends of which is formed the arc which is utilized in the process. The outer ends of the carbon rods 1 and 2 are seated in socket pieces 3 that are rotatably mounted in heads 4, having gear-wheels 5, 6 and 7 that receive motion from a rod or shaft 8, on which the gear-wheel 5 has a sliding non-rotatable fit. The rod or shaft 8 is provided at one end with a handle 9, and the hubs of the wheels 6 are mounted upon screw-rods 10, the inner

ends of which are supported by stationary heads 11, which also support the inner ends of the carbon rods 1 and 2. All of the parts thus far described are supported by a frame 12, that is pivoted at 13 to a standard 14, so as to permit the operator to raise and lower the arc by means of the handle 9. The standard 14 is so mounted on a base plate 15 as to be turned on a vertical axis by means of the handle 9 to effect any desired lateral adjustment of the arc. Suitably mounted to rotate upon or with a shaft 16 is a table 17, having a suitable number of notches or slots 18, the width of each slot being slightly less than the diameter of the bead 19, on the end of a glower 20, so that a glower may be inserted in each slot and be suspended by means of a previously formed bead on one end from the upper side of the table. The shaft 16 may be inclined to the vertical, as indicated, so that if all of the notches 18 are provided with glowers those on the side opposite the arc will not engage with the carbon as the table is rotated. A suitable device 16*a* may be employed for adjusting the height of the table in accordance with the length of glower that is desired. The table will obviously be located at a definite height for any given length of glower, and so the lower end of the blank will project substantially into the middle of the arc. At a suitable distance from the arc is located a fixed screen 21, on which is placed a horizontal line 22, and at a suitable point between the screen and the arc is placed a magnifying-lens 23, the lens being placed in such position as to project upon the screen a magnified image of the arc and the lower end of the glower. Since the employment of a single lens will serve to project a reversed image upon the screen, the line 22 will be located at the height corresponding to the length of glower desired. Since the projecting image is several times the size of the object, the length may be very accurately measured. In performing the method, glower-blanks, which have been formed in the usual manner, each with a bead at one end, are placed in the slots 18, in the wheel 17, so that the previously formed beads rest upon the upper edges of the slots. The frame 12 will then be so adjusted, both vertically and horizontally, as properly to locate the arc with reference to the lower end of the glower-blank at the inner side of the table. Any desired adjustment of the carbon rods with reference to each other may also be effected by rotating the handle 9. It will be seen, therefore, that the operator has complete control of the position of the arc. Inasmuch as the gauge line 22 and the table slot 18, which is located above the arc, have a definite fixed relation to each other as regards elevation, a given length of glower may always be secured by giving the table a small rotative movement as soon as the inner side of the bead coincides with the gauge line. The glowers may thus be successively moved into position for treatment, and as the table is rotated the completed glowers may be removed and their places filled by blanks, thus making the operation substantially continuous.

The Marconi System and the Yacht Races.

Melville E. Stone, general manager of the Associated Press, contracted with the Marconi Wireless Telegraph Company to report the yacht races and this was carried out with great success. Mr. Stone chartered the fast and commodious steam yacht Chetolah, owned by A. J. Wise, the head of the well-known electrical house of J. H. Bunnell & Company, and from its deck the bulletins were sent every few moments to the Marconi station at Jamaica, L. I., forwarded from there to the headquarters of the Associated Press on Broadway, New York city, and instantly distributed throughout the country. As the first day was foggy at times, the races could not have been reported during these periods with any promptness in any other manner, and the results were of great satisfaction to the Associated Press and its newspapers, and was an undoubted triumph for the Marconi service.

The editor of this journal was a guest of the Associated Press on the occasion on board the Chetolah. The following message was received from him by wireless service at the ELECTRICAL REVIEW office immediately after the first race was declared off.

On board yacht Chetolah,
By Marconi wireless telegraph:

Race declared off at three forty-five, Reliance having sailed one-half course several minutes ahead of Shamrock.

The Associated Press was represented on board by a very able staff of experts, and the Marconi Wireless Telegraph Company of America was represented by William H. Bently and George W. Fishback. The operator for the wireless service was F Newman, and notwithstanding that there were other wireless systems in operation, the thirty odd bulletins sent out were received promptly and correctly.

Index of the Technical Press.

The July issue of the *Index of the Technical Press* contains about 2,900 references to technical articles appearing in the technical press within the last month or so. This index covers practically all the technical journals of the world, making it very valuable to students and engineers.

Street Railways of Leipzig.

Mr. Brainard H. Warner, Jr., consul at Leipzig, Germany, has submitted the following interesting communication:

In the spring of the year 1872, the first street-car line in this city was opened to the public. The cars were, of course, drawn by horses—as they were at that time in almost every other place. It continued in operation until 1895.

CONCESSIONS.

In 1895 the Leipzig city council, the Minister of the Interior concurring, granted concessions to two companies to build electrical street railways upon conditions almost identical, the principal features of which are: The concessions extend forty years from the date the lines were first put into operation (in 1895 and 1896, respectively), at the end of which time all the lines and rolling stock which were then built, or which may thereafter have been built, are to revert to the city, with the exception of the grounds, buildings, machinery, and those motor cars which shall have been built within the last preceding five years.

Rights of City—The city has the right, however, to buy such grounds, buildings, machinery and cars at the price at which they are assessed. In addition thereto, the city has the right to take over the lines after the expiration of twenty years upon the payment of the full assessed value of the grounds, buildings, machinery and those motor cars which shall have been built in the five years immediately preceding, and the full assessed value of the roadbeds and rolling stock; after twenty-five, thirty or thirty-five years, in addition to paying the full price for the grounds, etc., seventy-five, fifty or twenty-five per cent of the assessed value of the roadbeds, etc., respectively. The city must also pay, should it take over the lines, or either of them, at the end of twenty years, thirteen times the amount the net profits have averaged during the five years just preceding; after twenty-five, thirty or thirty-five years, ten and three-fourths, eight or four times the average net profits, respectively. From the receipts, the running expenses, 4.5 per cent for dividends upon the capital stock, and a like sum for interest on the bonds are to be deducted in order to determine the net profits.

Forfeiture of Rights—The right of either company, or both, may be forfeited should one or both of them discontinue running cars along all of the lines or any part or parts thereof without the sanction of the local authorities; if they fail to comply with any ordinance within a

reasonable time after having been requested to do so in writing; if the funds for running expenses be attached or are otherwise made away with, or if the Royal Ministry should advise that such action be taken.

Stockholders' Rights—If, on account of any of the foregoing reasons, the city should take over the roads or either of them, it must pay to the stockholders of the company or companies an amount which a specially constituted board of experts may determine the plants, equipments, grounds, buildings, etc., to be worth.

Payments for Street Rights—After the first three full years the lines are in operation, they must pay the city for the use of the streets two per cent of the gross receipts, which amount will be increased one per cent after the lapse of every five years, until it reaches five per cent. The lines must pay for paving and repairing the streets where new tracks are put down, in the one instance, and where the running of the cars is responsible for the wear and tear thereof, in the other.

CAPITAL.

The Grosse Leipziger Strassenbahn Gesellschaft, the larger company, known as the "Blue Line," is capitalized at 10,000,000 marks ($2,380,000), which is divided into 10,000 shares of 1,000 marks ($238) each. It has a bonded indebtedness of 10,000,000 marks ($2,380,000), bearing four per cent interest per annum, which is divided into 6,500 bonds of 1,000 marks ($238) each, and 7,000 bonds of 500 marks ($119) each. The company has paid regular dividends to its stockholders since 1896, when it began operations, as follows: For the years 1896, 1897, 1898, 1899, 1900, 1901 and 1902, six, eight, eight, eight, seven, five and one-half and five and one-half per cent, respectively.

The Leipziger Elektrische Strassenbahn Gesellschaft, the other, known as the "Red Line," is capitalized at 6,250,000 marks ($1,487,500), which is divided into 6,500 shares of 1,000 marks ($238) each. It has a bonded indebtedness of 4,000,000 marks ($952,000), bearing four per cent interest per annum, which is divided into 2,000 bonds of 1,000 marks ($238) each and 4,000 bonds of 500 marks ($119) each. Regular dividends have been paid the stockholders since its organization, as follows: 1895 to 1899, four per cent per annum; 1900, three per cent; 1901, two per cent, and 1902, two per cent.

EQUIPMENT AND ROLLING STOCK.

The overhead trolley system is used by both companies. The trolley wires are suspended in the air by wires fastened to the houses on either side of the streets. Where there are no houses, iron posts, located perhaps two feet in from the curbstone, are used as supports. The tracks are laid with such exactness and precision that there is little delay or annoyance caused by the trolley arm becoming displaced.

The lines have 211.57 kilometres (131.17 miles) of tracks, including those in the various car sheds, 124.51 kilometres (77.2 miles) of which belong to the larger company and 87.06 kilometres (53.97 miles) to the smaller. The former has had, for several years past, its own car shops. It has 275 motor cars and 112 closed and thirty open trailers—in all, 417 cars in use. The smaller company has 130 motor cars and twenty closed and thirty open trailers—in all, 180 cars in use. The smaller company's cars are fitted with the ordinary hand brakes, while those of the other (the Blue Line) have the latest Westinghouse air brakes attached, in addition to the hand brakes. All cars are lighted by electricity, oil lamps being sometimes placed in one corner at either end, but, strange to say, none of the cars is heated, even in the coldest days in winter. In winter the car floors are covered with straw, and strips of cheap cotton-plush cloth are hung before the windows to keep at least some of the cold air off the passengers' backs.

AUTOMATIC SIGNAL BOXES.

An automatic signal box was first introduced by the smaller company last year. These boxes are placed at the crossings of electric street railways to warn motormen of the approach of cars in another direction. They have been found to be very satisfactory by both companies, as they are no longer compelled to station flagmen at the crossings or to have the conductors run forward to see if the way is clear.

TRAFFIC AND SERVICE.

Cars are run from 5.17 in the morning until midnight, upon schedules varying from four to fifteen minutes apart. Municipal ordinances prescribe that street cars shall not run at a higher rate of speed than nine miles an hour in the business sections; with trailers, 7.2 miles; and in the suburbs, fifteen miles, or twelve miles with trailers. Cars are not to be stopped at every corner to let passengers on or off, but at places perhaps 250 yards or less apart, marked for the guidance of the public by iron signposts placed a foot or two in from the curbstone.

To each motor car there is a motorman, who is forbidden to talk with passengers, and a conductor, whose duty it is to be on the back platform every time the car stops to help passengers on or off. A municipal ordinance requires that when a trailer is attached another conductor must be carried to look after it. Trailers and motor cars are not connected by a passageway, and passengers are not allowed to go from one to the other without paying an additional fare. There are twenty seats in each car and when all are taken no more passengers are allowed inside, as the aisles must be kept clear.

There are a certain number of standing-room places on the front and rear platforms—perhaps fifteen on an average. When these are taken and the inside is full, the conductor hangs out at the rear end of the car by the entrance a sign "Occupied," and no more stops are made to take on passengers until some are first let off.

FARES.

The fare for a single trip is ten pfennigs (2.38 cents), which entitles one to a free transfer. Passengers carrying large baskets, bundles, etc., must pay a full fare for such.[1]

The Red Line issues six tickets for fifty pfennigs (11.9 cents). Both lines issue commutation tickets good for three, six and twelve months, respectively. Postmen and telegraph and messenger boys are carried by contract, the Imperial Government paying a yearly sum therefor. More than seven at a time, however, may not ride on the same car.

All employés of the city, as well as those connected with the police department, when in uniform, are entitled to ride upon the front platform free of charge, but never more than two at a time. In addition thereto, a large number of the city officials—at the present time 560—are given "annual passes."

To school children under fifteen years of age are issued special cards, which are good only upon the lines running between their respective homes and the schools they attend and between certain hours of the day. Under no circumstances are these children allowed to get on or off the cars while they are in motion.

In the year 1902 the cars of the Grosse Leipziger Strassenbahn Gesellschaft traveled 14,399,902 kilometres (8,927,939.24 miles) and received 4,241,973.83 marks ($1,009,589.77) for carrying 45,007,637 passengers. The company's receipts were 9.4 pfennigs (2.24 cents) per passenger and 29.5 pfennigs (7.02 cents) per car kilometre (0.621 mile).

The cars of the Leipzig Elektrische

[1] A pernicious habit on the part of many, which may be said to have almost become a local custom, is that of feeing conductors. This is practised by even those who are in most moderate circumstances. A passenger paying the regular ten-pfennig fare will, at the time the fare is paid, hand the conductor an additional five pfennigs (1.19 cents).

Strassenbahn Gesellschaft during the same period traveled 565,004 kilometres (350,302.48 miles) and received 1,659,407.95 marks ($395,062.86) for carrying 18,160,928 passengers. The receipts of this company were 9.1 pfennigs (2.16 cents) per passenger and 26.02 pfennigs (6.53 cents) per car kilometre.

WAGES.

The wages of a conductor is eighty-four marks ($20) per month for the first year's service; the same amount is paid a motorman for the first six weeks he works. After their respective apprentice terms have expired they are paid from ninety marks ($21.42) to 120 marks ($28.52) per month, the amount being fixed by the length of time they have been employed. The men are given one day off in every six, seven or eight, depending upon the number of hours each one is compelled to work daily. A working-day is usually from ten to twelve hours.

CLEANING AND REPAIRING STREETS.

In the expenses are included the cost of new materials, repairs and cleaning and repairing the streets. As to this last mentioned, it should be said that the streets are cleaned and sprinkled by the city government, for which service the railway companies are charged as follows: For sprinkling and cleaning streets paved with asphaltum, granite blocks, macadam and wood blocks, three pfennigs (0.7 cent), two and one-third pfennigs (0.6 cent), five-sixths of a pfennig, (0.2 cent), and three pfennigs (0.7 cent) per square metre (10.7 square feet) per month, respectively, and, in addition thereto, five per cent for supervising the work. Last year the Blue Line paid 76,416.95 marks ($18,187.25) and the Red Line 48,663.76 marks ($11,581.97) for this purpose. Street paving and repairing is done by contract. The city, however, superintends the work, to see that it is properly done, and for this service charges five per cent of the contract price. Last year the Blue Line paid 239,502.15 marks ($57,001.51) for this purpose, and the Red Line 138,267.21 marks ($32,907.60).

In winter when the snow falls the street-car companies must keep their respective tracks clear, and for this purpose snow plows are used. The Blue Line has fifteen such plows and the Red Line six. The snow is piled on either side of the tracks and carted away by the city, which charges the street-car companies from 1.80 marks (43 cents) to 2.75 marks (65 cents) per wagon load containing about two cubic metres (seventy-one cubic feet), the price depending upon the length of the haul. Last year the Blue Line paid 9,723.85 marks ($2,314.28) for having snowed cleared away.

INSURANCE OF EMPLOYES.

For the benefit of those employés whose wages do not exceed 2,000 marks ($476) per annum, sick, accident, life insurance and assurity funds are established. These are also charged to the expense accounts, as is also the cost of the employés' uniforms, each man being provided with at least one uniform, two caps, an overcoat, etc., per annum, except, however, those who are working for the first year, from whose wages ten pfennigs per day is deducted to pay for the uniforms. Under taxes are included the two per cent of the total receipts, which were mentioned in the paragraphs entitled "Concessions," taxes upon real estate, revenue stamps, etc.

FINANCIAL STATEMENT.

The condition of the two railway companies at the end of the calendar year 1902 is shown in the following statement:

Debit.	Blue Line.	Red Line.
Salaries	$278,335.48	$107,710.44
Expenses	296,370.18	136,566.67
Taxes	35,917 36	14,995.58
Interest account	98,175.54	45,431.32
Gross profits	309,391.65	94,8 4.40
Total debit	$1,018,190.21	$399.538.41
Credit (total income	1 018,190.21	399,538.41

The Production of Copper in 1902.

In his report to the United States Geological Survey on the production of copper in 1902, Mr. Charles Kirchhoff says that the copper-mining industry of the United States suffered during 1902 from the reaction which followed the unsuccessful attempt during 1901 to maintain the value of the metal at an artificial level. The collapse which came toward the close of 1901 left many producers committed to sales covering a long period, at low prices, with the menace of heavy accumulations of metal constantly over the market. Yet production was heavier during 1902 than it had been in 1901, because some of the important mines were worked to full capacity and because some of the enlargements and improvements previously begun became effective during the year. Furthermore, a number of new enterprises first produced important quantities of metal. On the other hand, accidents and labor troubles cut down the outputs of some of the larger undertakings. Unless unforeseen events cause widespread or prolonged stoppage of operations at the mines, Mr. Kirchhoff thinks that the production of copper in the United States will be considerably larger in 1903 than it has ever been. The Lake Superior district will yield considerably more copper; Arizona is expected to return a considerably larger product; Utah may reach a total of 35,000,000 pounds; and Wyoming, Nevada, Colorado, New Mexico, and the southern states will report an increase.

The consumption of copper in the United States was enormous in 1902. It was larger also in other leading industrial countries.

As compared with 268,782 long tons in 1901, the total production of copper in the United States in 1902 was 294,423 long tons of which the Lake Superior district produced 76,165, or 25.9 per cent; Montana, 128,975 long tons, or 43.8 per cent, and Arizona, 53,547 long tons, or 18.2 per cent. This is an increase in the total production of 25,641 long tons, or nearly ten per cent, as compared with 1901.

Utah is forging to the front as one of the most important copper states, and it is notably in the Bingham Camp that development has been most rapid.

Only small quantities of copper ore have been shipped from Alaska to Puget Sound smelters, but it is known that large deposits of copper ore exist, whose development is being taken seriously in hand.

The imports in copper ore in 1902 were valued at $7,921,641, as compared with $14,394,663 in 1901; and the imports of copper in bars, ingots, pigs and in manufactured forms were valued at $12,864,021, as compared with $11,820,459 in 1901. The exports of domestic copper in different forms were valued at $46,811,729 in 1902, as compared with $36,071,448 in 1901. The exports from Baltimore, Md., increased from 54,377,355 pounds in 1901 to 103,607,256 pounds in 1902; and from New York the increase was from 133,540,150 pounds in 1901 to 236,622,515 pounds in 1902.

In the aggregate the reporting mines had a stock of 155,665,652 pounds of copper on January 1, 1903, as compared with 282,014,297 pounds on January 1, 1902, a decline of over 126,000,000 pounds during 1902.

The estimated consumption in 1902 was 551,688,191 pounds, as compared with 382,761,014 pounds in 1901, and with 356,891,121 pounds in 1900. The average selling price of Lake copper during 1902 was 11.86 cents per pound.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electric Elevators.

The accompanying illustrations show two of the types of electric elevators built by the Otis Elevator Company, 71 Broadway, New York city. Fig. 1 shows the apparatus used in connection with the electrical system of control. The contacts are of liberal proportions and every part is built in the most substantial manner.

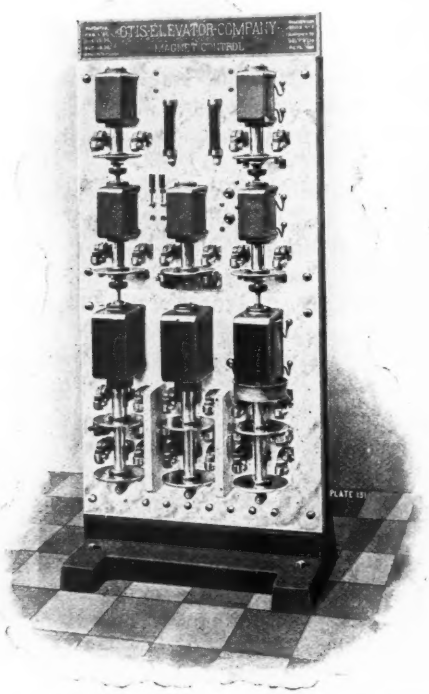


FIG. 1.—MAGNET CONTROLLER FOR ELECTRIC ELEVATORS.

Fig. 2 shows the apparatus for mechanical control. The main line or reversing switch shown in the upper part of the illustration is operated mechanically, and the smaller switches below, which cut out the starting resistance, are operated by magnets, as shown in the large controller in Fig. 1.

There are two systems of control for electric elevators—the electrical and the mechanical. In the former, the elevator is controlled by a small switch within the car, operating pilot circuits which open and close the main line and reversing switches. On starting, there is considerable resistance within the armature circuit, and as the armature accelerates, this resistance is automatically cut out step by step by electrically operated switches. By this means the current is absolutely prevented from increasing above the amount for which the motor is designed, and a gentle start proportionate to load is secured.

The mechanical system of control differs from the electrical in that the line switch is opened, closed and reversed through the medium of a lever or a handwheel within the car by purely mechanical means. Closing the switch admits starting current only to the motor, and thereafter the control proceeds in the manner already described, in the respect that the starting resistance is cut out from the armature circuit by automatic switches step by step as the motor accelerates, the same protection of the motor against heavy currents being thereby afforded.

Fig. 3 illustrates the Otis standard drum-type of the direct-connected elevator engine, placed immediately over the hatchway where ordinarily the overhead sheaves would be located. This method of installation has many desirable features, an important one being the entire freedom from elevator machinery in the basement space, which in many buildings is very valuable.

The double-worm electric machine shown in Fig. 3 is recommended for high-speed passenger service, rather than the single-worm type. It is provided with electrical control only, the controlling apparatus being also located overhead adjacent to the engine. The double worm is equally adapted, of course, for installation in the basement, and is so located in thousands of buildings where basement space is particularly valuable or where this method is for other reasons favored by the architects or engineers.

Fig. 4 shows an electric elevator with push-button control. This type of elevator is designed particularly for private residences. No attendant is required, the elevator is always ready for service, and it is equipped with every safeguard which human ingenuity can devise against disability or accident. A passenger desiring to use the elevator presses a button placed near the elevator shaft, and the car, if not in use, immediately travels to that floor and stops automatically. When the car has come to rest at that floor, the door can be opened. The passenger then enters the car and closes the door. The car will not leave that floor unless the door is tightly closed. Inside the car there is a series of push-buttons numbered to correspond with the various floors. The passenger pushes the proper button and the car proceeds to the desired landing and stops automatically. Not until the passenger has left the car and closed the door can the elevator be controlled from any other floor. Should the passenger desire for any reason to stop the car at any point in its travel, he can do so instantaneously by pushing the safety button with which the car is provided.

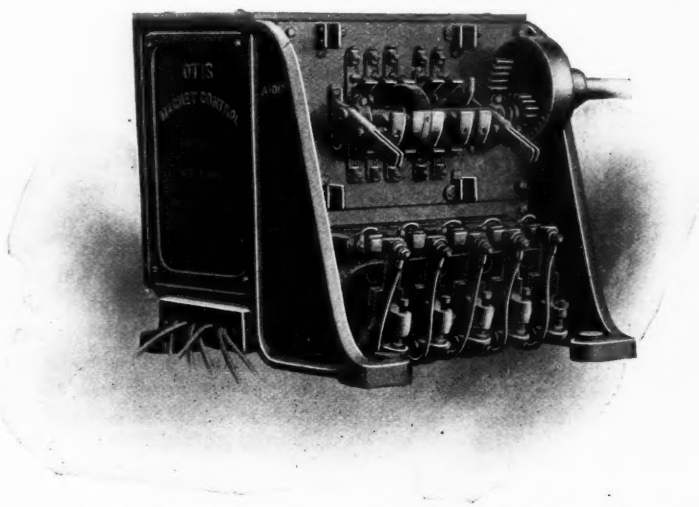


FIG. 2.—SEMI-MAGNET CONTROLLER FOR ELECTRIC ELEVATORS.

This type of elevator, although originally designed for private residences, has been installed with most satisfactory results in apartment houses, hospitals and

other places where the service is intermittent and it is desired to do away with the expense of an attendant.

The long and varied experience in elevator manufacturing has enabled this company to produce an electric elevator which in operation has been preeminently successful. The company has in actual operation at this time more than 10,000 electric machines in the United States and foreign countries.

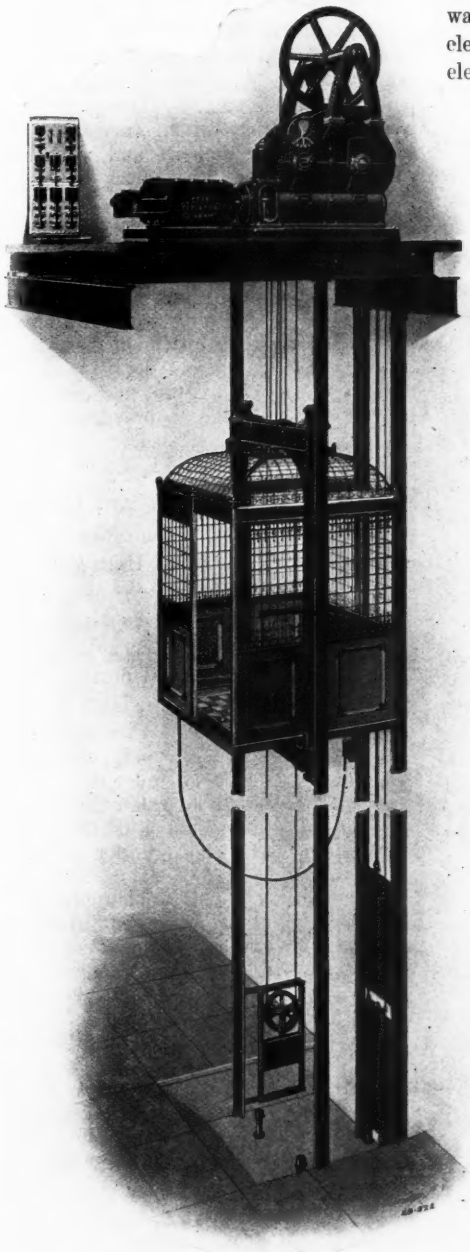


FIG. 3.—DRUM TYPE ELEVATOR ENGINE PLACED OVER HATCHES.

The illustrations herewith only give an idea of the elevator apparatus manufactured by this company. The company also makes electric elevator engines with single and double-worm gear, for both direct and alternating currents; electric dumb-waiter engines; internal geared electric freight engines; single-belt electric freight elevators; combination passenger and freight elevator engines; electric sidewalk hoists; vertical-cylinder hydraulic elevators; horizontal-cylinder hydraulic elevators; high-pressure inverted plunger hydraulic elevators; pulling plunger hydraulic passenger elevators; direct steam passenger elevators; steam belt freight elevators; safety devices, steam hoists for marine work; electric dock hoists; hydraulic ash hoists, and escalators.

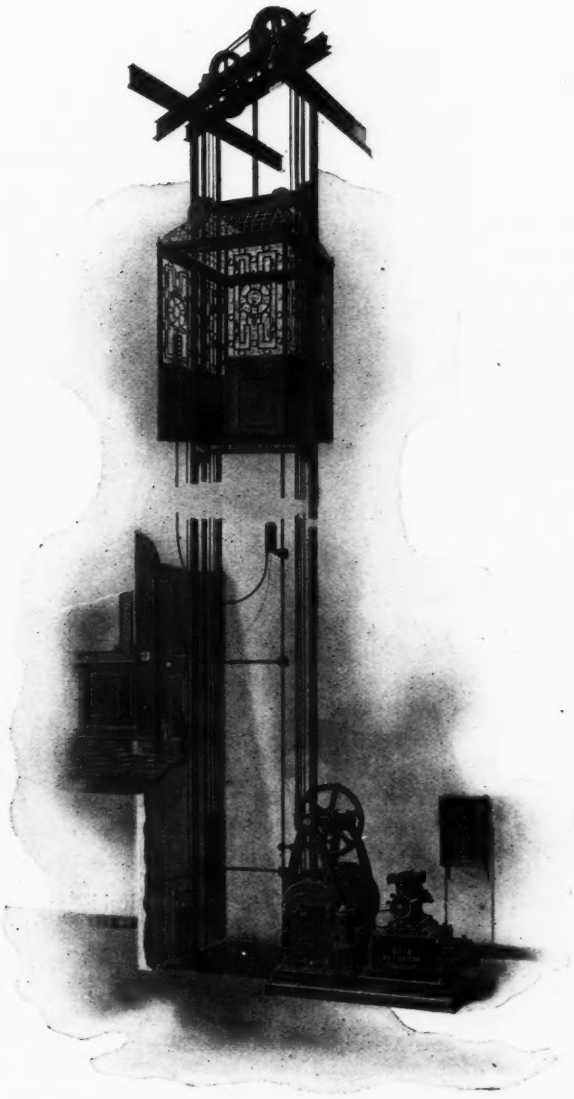


FIG. 4.—ELECTRIC ENGINE WITH PUSH-BUTTON CONTROL.

New Artificial Gutta-Percha.

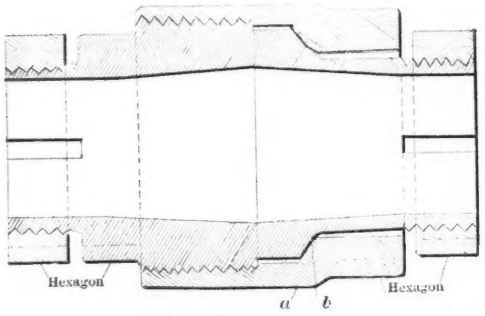
A new concern has been started in England, with a branch in Germany, to manufacture artificial gutta-percha under the "Gentzsch" patents and rights.

If the material should indeed realize the eminently satisfactory reports which have so far been obtained, there ought to be a very large market for this product, especially in view of the ever-increasing demand and the shrinking supply of the natural product. A well-known European expert is quoted as saying:

"I have recently had an opportunity of seeing some further results obtained by the German post office with submarine and land cables insulated with this new dielectric, and these results fully bear out the claims made by the inventor for the favorable qualities of his products."

The Double Conical Cable Joint.

The Electric Cable Joint and Appliance Company, 13-21 Park Row, New York city, has placed on the market a



NEW TYPE CABLE JOINT.

new form of cable joint which is meeting with ready acceptation in both repair and original work. The prominent feature of this cable joint is the great area of contact which is allowed, and another feature of probably equal importance is the great rigidity and strength which is given the joint by the nature of its construction. The drawing herewith presents a sectional view of the cable joint. The joint in its entirety consists of five pieces, and the operation is as follows: The flanged nipple on the right-hand side is so arranged as to carry with it the enlarged sleeve, at the same time allowing the sleeve to have great freedom of movement, which is necessary when the joint is tightened up. The left-hand nipple carries two threads, the extreme left of the nipple having a slot cut diametrically for about half an inch of its length. A nut engages with a thread on the left end of this nipple, and when the cable is inserted the nut is screwed up on the nipple, which causes the nipple to grip the cable very securely. This operation is repeated with the right-hand nipple, and then with a punch or nail a small hole is made in each end of the cable to be joined. A soft commercial copper double conical plug is inserted one end in each end of the cable, and the thread on the outside sleeve is then engaged in the thread of the left-hand nipple, and the whole is brought up to a tight finish.

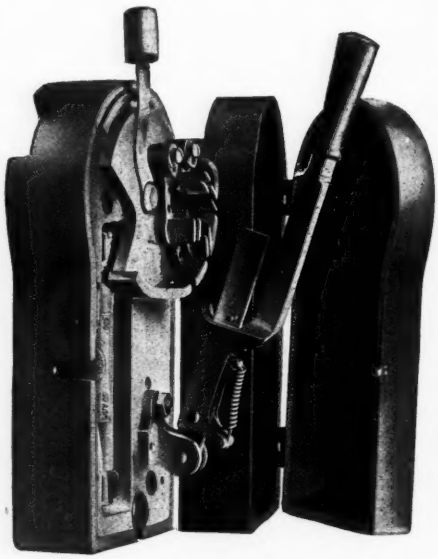
The following figures have been given,

CAR HEATER FOR HEAVY CARS.

showing the large area of contact which this joint affords, and proving that the area is very much in excess of that of the cable itself. At the same time, the tensile strength of the joint, which is made of heavy brass casting, is greater than that of the cable in its best part. In the present instance a cable of 1,000,000 circular mils was measured. This cable had a diameter of 1.152 inches, giving an area of 1.042 square inches. The diameter of the cone is 0.5 inch, giving an area of 0.196 square inch. The area of the shell at *a* is 1.288, plus the cone area, 0.196, making an area of 1.484. The contact area at *b* exceeds 1.031, plus 0.196, giving an area of 1.227 square inches. The outside diameter of the joint is two and three-eighths inches, the total length of the joint being four inches. A number of tests have been made, which show no discrepancy in the drop across the joint with same length of the cable with which the joint is to be used.

Electric Car Heaters.

The H. W. Johns-Manville Company, New York city, is manufacturing a new



THREE-POINT CAR HEATER REGULATING SWITCH.

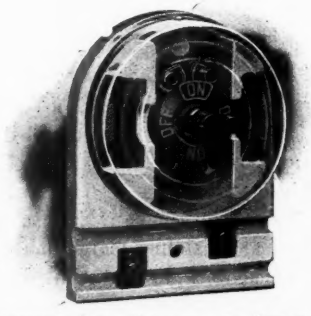
and desirable style of car heater for large interurban electric cars. The construction of this heater is similar to this company's well-known Class K heater, which has been on the market for several years and is used in cars having cross seats. Each heater is thirty inches in length and five inches in height, containing two three-quarter-inch double enameled angle irons held firmly in place by reconstructed granite heads or supports located at each end of the heater. These irons support the resistance coils and furnish superior insulation, thereby preventing short-circuits and the cutting out of resistance, due to contact formed by sagging coils. The casing is very strong and ornamental, and will stand a foot pressure without injury.

In order to meet the increasing demand of large electric cars requiring a greater number of heaters to satisfactorily heat them, the H. W. Johns-Manville Company is enlarging its three-point car heater regulating switch, increasing its capacity to sixty amperes and mounting in the insulating base block a Sachs "Noark" enclosed fuse. This complete controlling and protective device is now combined and enclosed in an iron box, requiring less room than heretofore and being absolutely safe and reliable under all conditions. Closing the quick-break knife blade automatically locks the switch, which is necessary before the cover of the box can be closed, and any movement of the regulator handles is prevented until the knife blade is released.

Combined Snap Switch and Cutout.

The accompanying illustration shows a new specialty which the Hart & Hegeman Manufacturing Company is placing on the market. This is a combined snap switch and cutout and is something entirely new among electrical devices. This device consists of a standard Hart double-pole switch mounted on a suitable procelain base, in connection with two cartridge fuses, all encased under one cover. The terminal clips into which the supply wires are placed are outside of the cover. The switch is furnished either with or without the fuses.

This specialty will be much appreciated by electrical contractors and wiremen. The new device will be found advantageous to control and protect motors, arc lamps and incandescent lamp circuits. It will also be found convenient for use as a service switch in small installations and for panel-board work. In factories and mills, and for general work where switches and cutouts can not be generally centralized, its use will be most economical, effecting a saving in wire and



COMBINED SNAP SWITCH AND CUTOUT.

cabinets. The manufacturer states that it is efficient, durable and safe, and has been approved by the Underwriters' National Electrical Association.

Municipal Electric Lighting Plant at Jewett City, Ct.

The municipal electric lighting plant at Jewett City, Ct., affords an interesting study of the application of a high-power internal-combustion engine for driving an electrical generator, to supply current for the lighting of a small town. Jewett City, Ct., is located on the Worcester division of the New York, New Haven & Hartford Railroad, about ten miles from Norwich. The plant was started about a month ago, and is the first central station in the United States to adopt the Diesel oil-burning engine. The use of this form of prime-mover does away with boilers, coal repositories, stokers, economizers or heaters.

The lighting system at Jewett City, prior to the installation of the new plant, consisted of a sixty-kilowatt, Westinghouse, 2,200-volt, sixty-cycle, single-phase alternator, driven by water power from the Aspenock bleachery. Consideration was given to the claims made by the manufacturers of the Diesel engine, and the town authorities decided to erect a plant on the west bank of the Pachaug River. The plant is located in a brick building, one story high, and the length of the structure is thirty-seven feet eight inches, and its width, thirty feet eight inches. The height, from the top of the foundations to the monitor-capped roof, is about twenty-six feet. A small brick chimney about eight feet high carries away the exhaust which is discharged from the engine cylinders. Before the exhaust enters the chimney, the gases pass through a muffler. The interior of the station is all white, and good ventilation and light are provided by windows on every side.

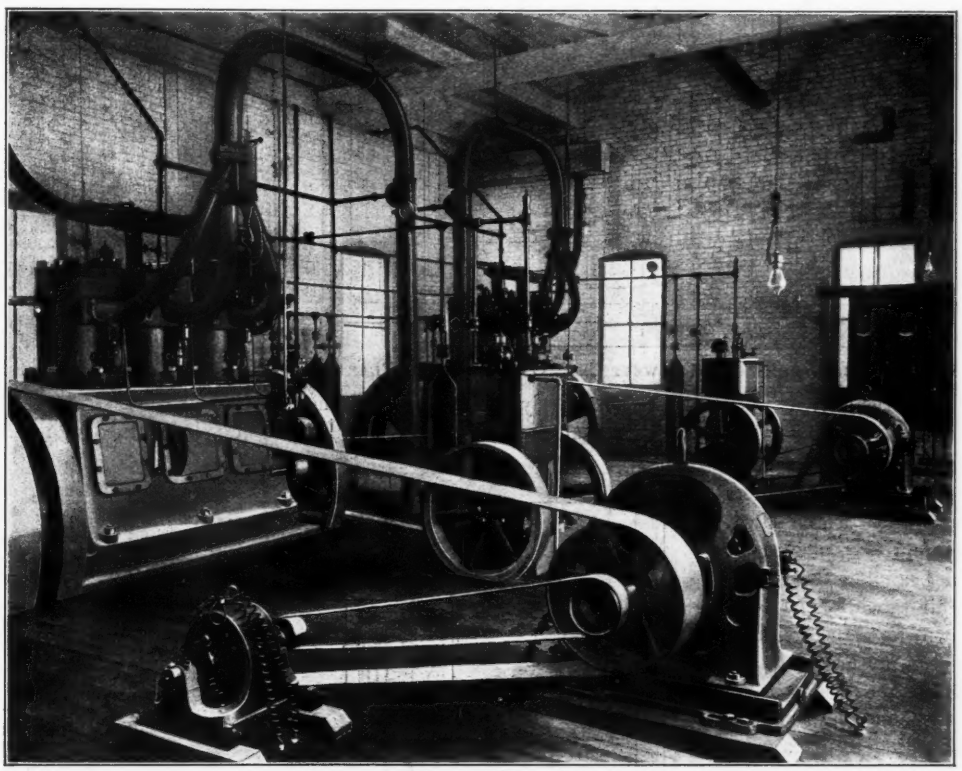
While, at the present time, the plant consists of a single room, space has been provided for a small office in the northwest corner. A double door, five feet wide, is built in the west wall, to permit of easily transporting machinery either into or out of the building. It is likely that in a short time one corner of the room will be fitted up as a repair room.

Two storage tanks, set under ground near the station, with a combined capacity of 6,500 gallons, supply oil for the engines. The crude oil is brought to the plant in tank wagons holding 640 gallons, and costs 4.6 cents per gallon delivered. The oil is pumped from the main tanks to a vertical tank holding forty gallons, and from this tank it is supplied to the engines.

Two fifty-kilowatt, Westinghouse, single-phase, 2,200-volt, sixty-cycle alternators are belt-driven by two seventy-five brake-horse-power, triple-cylinder, Diesel oil engines of the vertical marine type. The engine cylinders are of fifteen-inch stroke and ten inches in diameter, and the indicated horse-power of each engine is about 100.

These engines are built for the American Diesel Engine Company, 11 Broadway, New York city, by the International Power Company, Providence, R. I. The engines operate on the well-known Otto cycle of admission, compression, combustion and exhaust. They differ radically, however, from the ordinary gas and oil engines in the character of the combustion. This engine has three distinctive characteristics—first, the contents of the cylinder during the compression stroke is air only, and the temperature due to compression is considerably above that which is necessary to ignite the combustible charge; second, the clearance is only about seven per cent of the cylinder volume, and in this space is confined, under great pressure, more than enough air to supply oxygen for the combustion of any amount of fuel the engine is designed to use; third, the combustion of the fuel is not an explosion, but it burns as fast as injected into the cylinder, without increasing the pressure produced by compression.

The temperature due to compression ignites the combustible charge and does away entirely with the need of an electric spark or ignition tube apparatus.

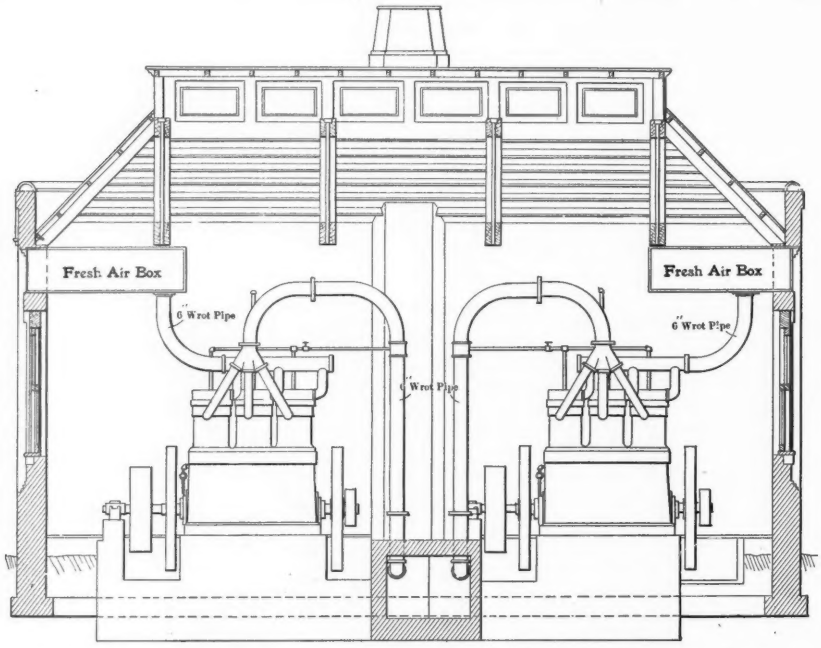


THE MUNICIPAL PLANT AT JEWETT CITY, CT., TWO 75-HORSE-POWER AMERICAN DIESEL ENGINES, BELT DRIVING WESTINGHOUSE ALTERNATORS.

The valve-operating cams are on the usual secondary shaft, driven by the main shaft through an intermediate gear. The admission and exhaust valves are driven by two of these cams. The movement of the admission valve particularly is very slight. The oil is driven into the cylinders by compressed air through a series of perforated brass washers, and enters the cylinders in the form of a fine spray. An auxiliary air compressor, driven by belt from the engine, supplies the air for this purpose. The air which supports the combustion is drawn into the cylinder through an automatic mushroom valve, and is compressed on the up-stroke to between 450 and 525 pounds pressure per square inch, corresponding to a temperature of about 1,000 degrees Fahrenheit. The fuel valve is open for about one-tenth of the working stroke, and the fuel is let in and consumed during the whole or a part of the period, as determined by the action of the governor. At the termination of the fuel supply, the resulting gases of combustion work expansively during the remainder of the stroke.

The fuel oil is delivered to the fuel admission valve by a pump driven from the cam shaft. One pump cylinder is provided for each of the main cylinders, and back of each is a by-pass valve which, when open, allows the oil to flow again to the suction side of the pump instead of to the valves. The length of time that these by-pass valves are open is controlled by the governor. Upon the relative distance between the top of each valve rod and its corresponding arm depends the length of time the valves are open and the consequent duration of oil supply for combustion purposes.

After the fuel valve closes, the gases work expansively, and the atmospheric and terminal pressures differ but little. The effect of the compressed air used to inject the fuel is inappreciable. The admission valve is open a constant length of time, but the fuel supply is controlled by the governor, so that only at full load is it injected into the cylinder during the entire period that the valve is opened.

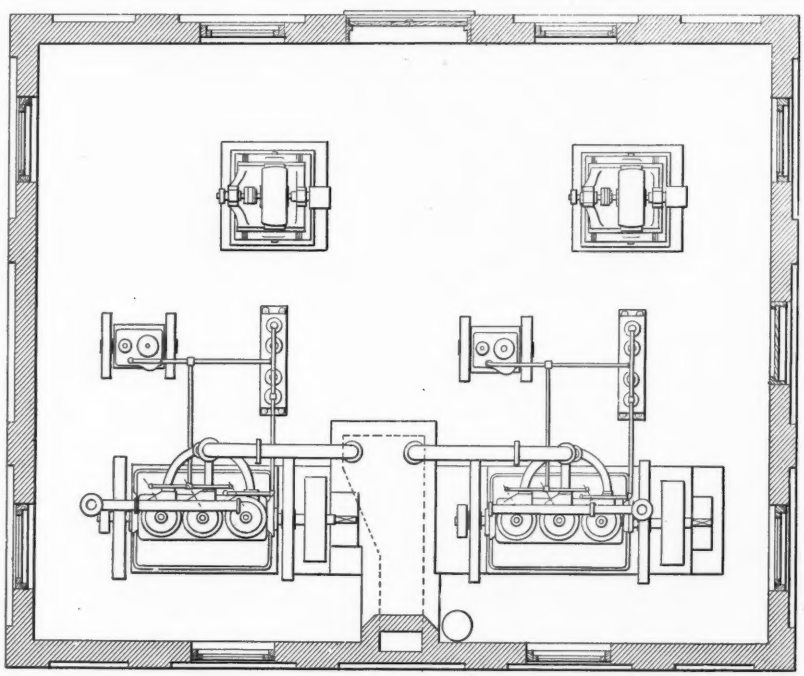


ELEVATION AND ARRANGEMENT OF ENGINES, JEWETT CITY, CT., MUNICIPAL PLANT.

The engine resembles, in outward appearance, the ordinary marine type of steam engine. The connecting rod is carried directly to a pin inside the piston, and the reciprocating parts are all enclosed within an engine housing. Automatic lubrication is used, and a reservoir is provided at the lower part of the housing which serves as a bath into which the connecting rod crank end plunges at each revolution. The machines are provided with double flywheels, in addition to the driving wheel.

The engines are started by compressed air from auxiliary reservoirs which are filled by an engine-driven compressor. A starting valve is opened, which admits compressed air to drive the piston for two or three revolutions, after which the compression in the cylinder is sufficient to ignite the charge. The starting cam is thrown out of action automatically as soon as the admission and exhaust valve mechanisms are thrown in. Enough air is always stored in these reservoirs to enable the plant to start with ease.

The accompanying drawings show the plan and elevation of the station. The auxiliary reservoirs are not shown located exactly as finally installed, but essentially no feature has been changed. On the east side of the building, just outside of the engine room wall, is located a wooden water tank with a capacity of 7,000 gallons. The water from this tank is circulated through the jackets of the engines, and is used over and over again. Each engine drives a small pump beneath the floor, which replenishes this tank when necessary.



PLAN VIEW OF JEWETT CITY, CT., MUNICIPAL PLANT.

The two alternators are mounted on timbers, and each is compound-wound, driving its exciter by belt. The exciters are each 1.5-kilowatt, 125-volt machines, and run at 1,300 revolutions per minute. These are also mounted on short timbers. The wiring from machines to the switchboard is carried below the floor level, and all 2,200-volt circuits are run in lead-covered cable.

The switchboard is composed of two panels of marbleized slate supported by a steel tubing frame, and is located on the south side of the room. The board is eight feet long and five feet high. Each machine is protected by an Elden circuit-breaker, which is modified so as to short-circuit the compounding winding at the rectifier after the exciter circuit has been opened automatically. Each panel contains a voltmeter and ammeter in addition to the circuit-breaker, and a double-throw, double-pole, interlocking switch for connecting the commercial circuits to either alternator. In addition, one panel carries two double-pole, single-throw exciter main switches and a double-pole, double-throw, horizontal station lighting switch, which throws the twelve and sixteen-candle-power incandescent lamps which illuminate the plant upon either exciter.

One of the panels also contains a double-pole, double-throw, quick-break switch for connecting the series street lighting incandescent circuit with either alternator. To provide against excessive voltage at the lamps in case if any one of the series lamps should burn out, and short-circuit through the base, six lamps have been installed on one of the panels in connection with a radial switch, which throws them in circuit, one by one, as may become necessary to replace burned-out lights. The street lighting circuit is also provided with an indicating ammeter. Rheostats for the alternator fields are to occupy the lower central portion of one panel of the switchboard.

At present there are two single-phase commercial circuits supplying house-to-house transformers, and one street series circuit made up of thirty-candle-power, 5.5-ampere incandescent lamps. The total connected load is equivalent to about 2,000 sixteen-candle-power lamps at present, and there are no direct-current circuits in the town.

Some interesting figures are shown in the economy of operation by the Diesel engine. The machines in this plant are guaranteed to operate on 0.47 pound of oil per brake-horse-power-hour at full load, and on 0.5 pound of oil per brake-horse-power from friction load to full load. With oil at 4.6 cents per gallon, this means about one cent per kilowatt-hour, including wages and supplies, the attendance being very small. The electrical apparatus was installed by H. B. Rust & Company, of Providence, R. I., and the engine and engine appurtenances were erected and furnished by the American Diesel Engine Company.

THE CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION.

THE TWENTY-SECOND ANNUAL MEETING, TO BE HELD AT SARATOGA SPRINGS, N. Y., SEPTEMBER 2, 3 AND 4.

The twenty-second annual meeting of the American Street Railway Association will be held at the Grand Union Hotel, Saratoga Springs, N. Y., Wednesday, Thursday and Friday, September 2, 3 and 4. The secretary has requested the chief executive officers of the different companies to notify all delegates and heads of departments attending the convention that they are expected to be present at all sessions of the meeting and take part in the discussions.

Saratoga is a very popular city for conventions, and the railroad men of this territory are anxious that a great showing may be made, and to this end elaborate preparations have been under way for the proper entertainment and disposition of all those present. A long programme has been arranged, and a number of papers will be presented for reading and discussion. The following subjects have been announced:

"Electric Welded Joints."

"The Evils of Maintenance and Champerty in Personal Injury Cases."

"Train Orders and Train Signals on Interurban Roads."

"Freight and Express on Electric Railways."

"The Manufacture and Distribution of Alternating Currents for City Systems."

"Comparative Merits of Single and Double-Truck Cars for City Service."

"The Right of Way."

An exhibit of street railway supplies will be held at the Grand Union Hotel, which will be the headquarters of the convention. Other first-class hotels are the United States, the American-Adelphi, Congress Hall, Worden and Kensington.

Among those who will occupy space in the exhibit parlors and have already made announcement will be the H. W. Johns-Manville Company, of New York city. This company's exhibit will occupy space No. 67, and its exhibit will consist of the latest developed devices pertaining to the Sachs "Noark" enclosed fuse apparatus, there being a number of large capacity fuse and service boxes, as well as several new designs of fuses. A very complete line of the latest up-to-date overhead line material, ears, clips, trolley wheels, insulated and metallic crossings and section insulators will be on display, as well as a complete line of electric car heaters. The souvenir this year will be a very attractive and useful keepsake. Those in attendance for the company will be J. W. Perry, manager electrical department, New York; J. E. Meek, New York; H. M. Voorhis, of the Philadelphia office, and James Humphreys, of the Boston office. The representatives of the Johns-Pratt Company, manufacturer of overhead line material, special insulating material and Sachs "Noark" enclosed fuse devices, of which the H. W. Johns-Manville Company is the sole selling agent, who will attend the convention are E. B. Hatch, president; Joseph Sachs, electrical engineer; J. C. Howell, purchasing agent, and W. H. White, superintendent.

The officers of the American Street Railway Association are:

President, Jere C. Hutchins, Detroit, Mich.

First vice-president, W. Caryl Ely, Buffalo, N. Y.

Second vice-president, W. Kelsey Schoepf, Cincinnati, Ohio.

Third vice-president, P. S. Arkwright, Atlanta, Ga.

Secretary and treasurer, T. C. Penington, Chicago, Ill.

The executive committee, in addition to the officers named above, is composed of the following:

Herbert H. Vreeland, New York city; Richard T. Laffin, Worcester, Mass.; Andrew Radel, Bridgeport, Ct.; Walter P. Read, Salt Lake City, Utah; Willard J. Hield, Minneapolis, Minn.

The International Association of Municipal Electricians.

The eighth annual convention of the International Association of Municipal Electricians will be held at Atlantic City, N. J., September 2, 3 and 4. The headquarters of the association will be at the Hotel Rudolf. Members and friends who desire to go *via* New York city should communicate with F. C. Mason, chairman of the committee on transportation, 16 Smith street, Brooklyn, N. Y. The train will leave foot of Liberty street, *via* Central Railroad of New Jersey, at 3.40 P. M., Tuesday, September 1. An interesting programme has been outlined. In addition to the social and entertainment features there will be given a lecture on wireless telegraphy by A. Frederick Collins, of New York, illustrated by apparatus and lantern slides. There will also be a demonstration of the Cooper Hewitt mercury vapor lamp and static converter, by Dr. Max von Recklinghausen and Percy H. Thomas. The associate members of the association will make an exhibit of apparatus at the Hotel Rudolf during the convention.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

A $2,000,000 CONSOLIDATION—The Worcester & Southbridge Street Railway Company, the Worcester, Rochdale & Charlton Depot Street Railway Company, the Southbridge & Sturbridge Street Railway Company, and the Worcester & Southbridge Development Company, with the Pinehurst Park and Hotel Overlook properties, are to be consolidated. The capitalization of the new corporation will be over $2,000,000, and it will be known as the Worcester & South bridge Railway Company. The consolidation of these three Massa chusetts street railways with the Worcester & Southbridge Development Company was decided on after a meeting of the directors of the roads last week.

EXTENSIVE MEXICAN ELECTRICAL SYSTEM—Announcement has been made of a project to build a 60,000-horse-power plant in the state of Jalisco, Mexico. The scheme includes the supplying of the city of Guadalajara with light and power and the building of electrical lines within a radius of some 100 miles of that city. The American syndicate, in which it is said W. A. Rogers, vice-president of the West Coast Land and Lumber Company, New York, is the leading spirit, has secured a concession to develop water power along the Santiago River, state of Jalisco, for a distance of about seventeen miles. San Cristobal, a town located about four miles from Guadalajara, will be the site of the principal station. It is expected to have 10,000 horse-power available in about one year.

CAPITAL RAISED FOR THE SUSQUEHANNA POWER DEVELOPMENT—The statement has been made that the Susquehanna Power Company, which was recently incorporated for the purpose of utilizing the water power of the Susquehanna River and conveying electric energy for use in Baltimore, Md., has secured subscriptions to nearly $10,000,000 of its capital. It is now announced that the company is about to sign a contract with a large electrical manufacturer for machinery involving an expenditure of from $2,500,000 to $3,000,000. The engineers and others identified with this project have been busy for the past six months making exhaustive investigations for northern and New England capitalists. Three developments of 50,000 horse-power each are planned, and it is said that the details of construction have been completed. The power company will furnish current to the United Railways and to the United Electric Light and Power Company.

THE PIKE'S PEAK, COL., DEVELOPMENT—Three miles of twenty-one-inch piping have been delivered on the ground of the Pike's Peak power plant being built on the east slope of Pike's Peak at a reported cost of $1,000,000. General Manager Taft is in Manitou overseeing the arrival of the first consignment at that point, and as fast as the piping is received it will be conveyed to the Half-way house and laid in the trenches already prepared for its reception. The pipe will be used to convey the city water from a point above the Half-way house through three miles of steel conduits to the power-house where the water will be dropped 2,240 feet. The water will pass through turbine wheels, generating 3,000 horse-power which will be used to operate the mills and industrial plants in Colorado Springs and adjacent cities. Work on making the excavations for the foundations of the new power-house is progressing rapidly, and by the middle of the month the first course of stonework will be put in.

WALES (ENGLAND) POWER COMPANY ORGANIZED—An important power plant has been projected by the North Wales (England) Power and Traction Company, which has just been organized in London with a capital of $1,350,000. It is proposed to generate electricity by means of water power from the lake in Snowden and in the neighborhood of Conway. The current will be supplied to a short railway and to certain towns in the district of Snowden to local quarry owners, and in bulk to more distant consumers. It is the intention of the company to tap Lake Llydaw, which lies on the eastern slope of Snowden, at an elevation of 1,416 feet above sea level. This lake is just over a mile in length, and averages about a sixth of a mile in width. This is equal to an area of about 5,500,000 square feet. It collects rain-fall from an area of about 47,000,000 cubic feet, and the average rain-fall in this territory is estimated at 170 inches per annum. A dam 150 feet long is to be built across a portion of the lake, raising the water twenty feet. The lake can be tapped thirty feet below its present level or fifty feet below the proposed level, which is estimated to be equivalent to a storage of at least 250,000,000 cubic feet of water. The location of the generating plant will be at a point 1,200 feet below the lake, with which it will be connected by steel pipes. It is estimated that 6,000 horse-power will be developed for ninety days, independent of any rainfall and permanent streams during that time.

THE RESERVOIR AT SPIER'S FALLS, N. Y., FILLED—The large reservoir formed by the dam at Spier's Falls, on the Hudson River, ten miles north of Glens Falls, has been successfully filled. The flow of the Hudson River was effectually stopped for about twenty-four hours. A fortunate coincidence in closing down at this period was the fact that heavy rains had been falling in the upper Hudson valley, and the opening of the Indiana River state dam. Below Spier's Falls for a considerable distance the bed of the river ran dry, and at Glen's Falls, Sandy Hill and Fort Edward all the mills were compelled to shut down. This was taken advantage of, however, by the different mill owners to effect a number of repairs to the masonry and sluiceways. The dam at Spier's Falls is of white granite, 157 feet deep, 115 feet broad at the base, twenty-two feet thick at a point eight feet below the top, and 1,570 feet in length from shore to shore. The reservoir created by the dam is some five miles long and a third of a mile wide. The intake canal for the power-house is on the east end of the dam. It extends 120 feet to the power-house below the dam and at right angles with it. At the entrance it is 130 feet wide in the clear, with a current of water twenty feet deep. The dimensions of the power-house are 392 feet by seventy feet, with a height of thirty-eight feet to the eaves. There will be ten head-gates regulating the water, each ten feet wide. Through the wall of the canal back of the power-house are the openings for the penstocks, each twelve feet in diameter, through which the flow is delivered to the turbine wheels below. The power-house is divided into three sections—the wheel room, the generator room and the transformer room. The wheel room is located on the east side, and extends almost the entire length of the building. The ten pairs of water-wheels are located here, each pair capable of generating 5,000 horse-power under an eighty-foot head. These wheels are controlled by various types of governors, so that they will run at practically constant speed for all changes of load. The wheels are set twelve feet above the water in the tail-race, and are connected with the tail-race by means of air-tight draft tubes. The generator room is directly west of the wheel room and is divided from the wheel room by a brick partition. This will be equipped with eight 2,500-kilowatt and two 2,000-kilowatt, three-phase, 2,000-volt, forty-cycle generators, each direct-connected to a pair of water-wheels. In the same room are two 150-kilowatt and one 300-kilowatt, 125-volt exciters, each direct-connected to an individual water-wheel. The transformer room is at the south end of the building and is forty feet by seventy feet. In this room are located thirty 833-kilowatt and six 770-kilowatt, air-blast, step-up transformers, with the necessary motors and blowers for furnishing air. Current will be generated at 2,000 volts and carried through cables laid in ducts under the floor of the power-house to the step-up transformers, where the voltage will be raised to 30,000 volts, and the current will then be transmitted through feeders to various centres of distribution, located within a radius of forty-five miles from Spier's Falls to Troy, Albany, Schenectady and intervening towns and cities.

PERSONAL MENTION.

MR. JOSEPH P. DEVINE, president of the National Battery Company, Buffalo, N. Y., spent a few days last week in New York city.

MR. GEORGE A. McKINLOCK, president of the Central Electric Company, Chicago, Ill., has been visiting New York city during the past week with his family.

MR. W. J. PHELPS, manager of the Phelps Company, Detroit, Mich., manufacturer of the famous "Hylo" incandescent lamp, has been spending some time in Chicago.

SIR WILLIAM PREECE, whose serious illness was mentioned several weeks ago, is understood to be convalescing rapidly, and the latest news is of such a reassuring character that it is expected he will soon be able to resume his practice.

MR. W. F. WEISS, 128 Broadway, New York, who is well known throughout the electrical industry as a public accountant, having acted in this capacity for a good many years with different electrical companies, has recently been appointed receiver for quite a large company. This is almost a precedence as the courts have seldom appointed an accountant as a receiver, and the appointment is considered a tribute to Mr. Weiss's ability and integrity.

MR. C. L. HIBBARD, who for the past few years has been Chicago representative of the Varley Duplex Magnet Company, has tendered his resignation, to take effect September 1. Mr. Hibbard will take charge of a new company which will manufacture and handle several electrical specialties. The name of the company will be announced later. The Chicago office of the Varley company will temporarily be in charge of Mr. William Balke, who for the past five years has been chief inspector at the factory of the Varley company.

MR. WILLIAM J. HAMMER, the well-known consulting engineer of New York city, with Dr. Amon Jenkins, of New York city, has undertaken a series of highly interesting experiments, using a combination of radium rays and Rœntgen rays, to stimulate and bring about a normal action in the paralyzed optic nerve. Several experiments which were performed on an eleven-year-old child in New York city recently have been commented on with great interest. Concerning the latest developments of these experiments, neither Mr. Hammer nor Dr. Jenkins was willing to prophesy any permanent benefit as a result of their work.

NEW INCORPORATIONS.

CAMDEN, N. J.—The General Traction Company. $1,000,000.

AUSTIN, TEX.—Pilot Point Light and Power Company. $30,000.

DES MOINES, IOWA—The Butler County Telephone Company. $10,000.

SARATOGA SPRINGS, N. Y.—Comstock Telephone Company. Increased from $500 to $1,500.

MERIDEN, CT.—The Connecticut Telephone and Electric Company. Increased from $36,000 to $45,000.

RALEIGH, N. C.—Troy Telephone Company. $100,000. Incorporators: J. R. Blair, O. M. Wade, W. A. Cochran.

JOHNSTOWN, OHIO—The Johnstown & Canton Telephone Company. Increased from $30,000 to $50,000.

SPRINGFIELD, ILL.—Alloway Electric Company. $2,500. Incorporators: Wilmore Alloway, Harry Alloway, Edward McMahon.

MILWAUKEE, WIS.—Eau Claire County Telephone Company. $5,000. Incorporators: C. A. Silkworth, J. J. Osborne and M. Cousins.

SCANDINAVIA, WIS.—Scandinavia Telephone Company. $1,500. Incorporators: George C. Willson, A. M. Peterson and O. H. Grenlie.

CLYDE, OHIO—Farmers' Telephone Company. $10,000. Incorporators: F. S. Johnson, F. Hutchinson, S. Decker, F. Royce, D. H. Good, C. C. Wright.

MARION, IND.—The Sims Cooperative Telephone Company. $7,500. Incorporators: Chauncey B. Knowlton, Edward Gillenwater, H. C. Haines and Isaac Rust.

WESTVILLE, N. Y.—Westville Telephone Company. $1,000. Incorporators: F. Green, A. Baldwin, T. Gurney, E. B. Coats, M. A. Stilwell, J. M. Cady and K. H. Baldwin.

TELEPHONE AND TELEGRAPH.

DAVEY, NEB.—The Nebraska Telephone Company will build a new line from Davey to Lincoln.

AUSTIN, TEX.—The Austin Telephone Company has increased its capital stock from $18,000 to $60,000.

WYOMING, ILL.—The Milo & Bradford Telephone Company has increased its capital stock from $5,000 to $20,000.

WILLIAMSON, N. Y.—The Rochester Telephone Company has established a local telephone system in Williamson.

WATERLOO, IOWA—The Iowa Telephone Company has secured permission of the city to place its cables underground.

PORTLAND, ME.—The selectmen of the town of Gorham have granted pole rights in that town to the Northeastern Telephone Company.

BRUNSWICK, MD.—The Chesapeake & Potomac Telephone Company is considering the plan of installing a telephone exchange in this town.

NORFOLK, NEB.—The Nebraska Telephone Company is preparing to rebuild its exchange in this city. Improvements will cost about $15,000.

SPRINGFIELD, ILL.—The Chesterfield Telephone and Telegraph Company, of Chesterfield, has been incorporated with a capital of $15,000.

CANAAN, CT.—The Farmington Valley Telephone Company, of New Britain, has filed a notice of an increase of capital stock from $10,500 to $27,000.

WARWICK, N. Y.—The Warwick Valley Telephone Company's lines are now connected by a metallic copper circuit, *via* Goshen, with the Orange County company at Middletown.

OLD TOWN, ME.—The Riceville Telephone Company has completed a line from Hancock Tannery to Greenfield and Cardville, connecting with the lines of the New England Telephone Company at Costigan.

INDIANAPOLIS, IND.—The Fisher Telephone Company, of Hamilton County, has been incorporated with a capital of $5,000. The directors are T. A. Fisher, T. A. Beaver, J. A. Noury, N. G. Manship and A. C. Harrison.

NEW YORK, N. Y.—Police Commissioner Greene has contracted with the New York Telephone Company for 661 outside telephones in the Borough of Manhattan, and with them a complete system of reporting to precincts will be inaugurated. The cost will be $20,855.20 a year.

CLEVELAND, OHIO—A telephone company has been organized in the eastern part of the county, with the following officers: R. A. Kerr, president; Dr. H. Davison, vice-president; J. N. Fraham, secretary; C. C. Kreps, treasurer. The company will confine its operations to Westminster, West Newton and vicinity.

HIBBING, MINN.—A complete telephone system has been installed by the Great Northern Railway Company on its line between Superior and all range towns. Telephones have been installed at Brookston, Fox, Ellis, Buhl, Chisholm, Hibbing, Mahoning, Kelly Lake and Virginia. The company's object is to relieve the telegraph wires as much as possible.

PATCHOGUE, L. I.—The Suffolk County Telephone Company has been incorporated to extend a telephone line along the south side of Long Island from Amityville to Montauk, and Patchogue has been asked to grant the company permission to erect its poles within the village limits. The directors of the company are H. Clay Losee, County Judge Walter H. Jaycox, Fremont Hammond, Joseph T. Losee, Moses F. Tiger, all of Patchogue, and Ralph C. Greene, of Sayville.

ALBANY, N. Y.—At a recent meeting of the stockholders of the Hudson River Telephone Company, it was voted to increase the capital of the corporation from $4,000,000 to $5,000,000. The increase will be used for extensions and improvements. The Howell Telephone Company, whose lines connect Monroe and Blooming

Grove, has made arrangements to cooperate with the Hudson River company. This will give the latter company a direct line from Washingtonville to Monroe and an additional circuit from Middletown to Newburgh.

LITTLE ROCK, ARK.—The Little Rock exchange of the Southwestern Telegraph and Telephone Company is installing 500 additional wires to the present switchboard of 2,599 wires, which will give it a total of 3,099 wires. The company is gradually extending its system to all parts of the state and taking over the companies in the smaller towns through which the lines run. Recently it purchased the exchange at Forrest City, and is now putting it in first-class shape. A new line has been opened from Augusta to Bald Knob, from Walnut Ridge to Black Rock and Powhatan, and construction has been begun on a line from Walnut Ridge to Pocahontas.

ELECTRIC RAILWAYS.

LITTLE FALLS, N. Y.—The Blue Ridge Traction Company has filed in the office of the recorder of deeds at Easton thirteen extensions of its route, aggregating about forty-nine miles.

ALBANY, N. Y.—The United Traction Company's line from Albany to Troy has been opened. Cars will run every hour and will go direct to Saratoga, the trip consuming about three hours.

DES MOINES, IOWA—The Council Bluffs, Tabor & Southwestern Electric Railway Company has been incorporated with $200,000 capital stock, to build an electric railway from Council Bluffs to St. Joseph.

PUEBLO, COL.—The Pueblo & Suburban Traction and Lighting Company is making many improvements to its system. Its power line from the mountains is now almost completed, and parts of its lines are now being practically rebuilt.

NEWPORT NEWS, VA.—The Hampton Roads Railway and Electric Company has filed a mortgage on its plant for $300,000, to cover a bond issue of that amount. The bonds are issued for the purpose of making extensive improvements.

SHAMOKIN, PA.—The Shamokin Railway Extension Company has been organized by Shamokin and Philadelphia capitalists. They purpose building an electric railway from Sunbury to Shamokin. It will be an electric express company, chartered to haul passengers, baggage and freight.

CARLISLE, PA.—It is stated to be certain that the trolley road to connect Carlisle with the battlefield of Gettysburg will be built. The line is already completed to Mount Holly, a distance of six miles, from which place the road will go to Zion Church, Bindersville, Biglersville and Gettysburg.

WORCESTER, MASS.—It is stated that a direct trolley line connecting Providence and Worcester is contemplated. Two routes between Worcester and the Rhode Island city are being surveyed, either of which will reduce the distance between the two cities thirty-eight miles. It is understood that the proposed route will be completed within a year.

JACKSON, MISS.—A project is under way to construct an electric railroad between Jackson and Vicksburg in the near future, by a company composed of New York, Chicago and local capitalists. The distance between the two cities is forty-five miles, and the engineers who have surveyed the route estimate that it will cost $15,000 per mile to build the line.

RICHMOND, VA.—Active work has been begun on the rehabilitation of the entire system of the Virginia Passenger and Power Company in this city and Manchester, which, when completed, will cost in the neighborhood of $500,000. The Seven Pines road is to be completely rebuilt, and the Lakeside, Forest Hill and Hull street lines to be thoroughly renovated.

MUNCIE, IND.—It has been announced by an official of the Muncie & Portland electric line, a branch of the Indiana Union Traction Company's system, that work will not be begun on the line before the end of the year. This delay is caused by the fact that the lines between Indianapolis and Logansport, Indianapolis and New Castle, Alexandria and Muncie, and Anderson and Franklin, must all be completed by January 1, 1904, according to their franchises.

GREENSBURG, IND.—It is reported that the capital for the construction of the Madison, Greensburg & Indianapolis traction line has all been subscribed, and that construction work will begin by June, 1904, and be completed within two years. The length of the line is forty-nine miles, and it will run from Madison, through Rexville, Versailles, Osgood, Napoleon and on to this city, where it will connect with the Indianapolis, Shelbyville & Southeastern Company's lines.

BRISTOL, TENN.—The Cumberland Transportation, Light and Power Company has been organized for the purpose of operating a system of trolley car lines in the coal fields of southwest Virginia. The main line proposed is to run from Coeburn to Toms Creek, thence to Wise, Norton, Esserville, Dudlick, Appalachia, Looney Creek and Big Stone Gap. The line will cover a distance of thirty miles of the most thickly settled portion of the mining districts of Wise County, Va.

FRANKFORT, KY.—The Madisonville Traction Company, of Jefferson County, has filed articles of incorporation with the Secretary of State. The capital of the company is $100,000, and Joseph Huffaker, W. H. May, C. C. McCarty, J. O. Duncan and O. B. Bates are the incorporators. The company will construct an electric railway line from Madisonville to Earlington, in Hopkins County, a distance of five miles; from Earlington to Nortonsville, six miles; from Nortonsville to White Plains, eight miles.

EASTON, MD.—The Eastern Shore Transport Company is said to contemplate building a trolley line from Cambridge Ferry to Wye Station on the Queen Anne's Railroad. A ferryboat will run from Cambridge to Cambridge Ferry, connecting with the trolley road. The line, which will be twenty-four miles long, will pass through a thickly settled section of Talbot County. It will connect the towns of Cambridge, Easton, Trappe, Longwood, Skipton and Wye Mills, by way of the Queen Anne's Railroad, with Baltimore and Philadelphia.

MACON, GA.—The Secretary of State has granted a charter for the Atlanta Interurban Railroad Company, with a capital stock of $100,000, with the privilege of increasing the amount at any time to such a sum as may be deemed necessary by the board of directors. The purpose of the company, as set forth by the petition, is to build an electric line from the Chattahoochee River, at a point near Collier's Bridge, to Smyrna, and from there to Marietta. The petitioners named in the application for the charter are officers and employés of the Atlanta Railway and Power Company, and it is believed that the latter company is interested in the project.

AUSTIN, TEX.—The charter of the Beaumont, Sour Lake & Port Arthur Traction Company has been filed by the Secretary of State. The principal offices are to be located at Beaumont, and the capital stock of the company is $300,000. The company will construct an electric line from Port Arthur to Beaumont, and thence to Sour Lake, in the counties of Jefferson and Hardin. The incorporators are C. W. Meeks, Houston; W. A. Smith, H. E. Smith, Theodore Weyant, Columbus, Ohio; John B. Linn, Springfield, Ohio; George A. Hill, Austin; George M. Craig, Port Arthur; B. R. Norvell, William Weiss, George W. Carroll, George W. O'Brien, W. C. Averhill, R. C. Duff, Beaumont.

PITTSBURG, PA.—Charters have been granted to the Coraopolis & Aliquippa Electric Street Railway Company and to the Monaca & Aliquippa Electric Street Railway Company, which propose to build important links in the trolley system connecting Pittsburg with the Beaver Valley. The former company has a capital of $30,000, and will build five miles of road, beginning on the public highway in Shousetown, Crescent Township, Allegheny County, and extending through Shousetown, Stoops Ferry and Coraopolis. The latter company will build ten miles of road, beginning at Monaca, Beaver County, and extending through the townships of Moon and Hopewill to Aliquippa, and has a capital of $60,000. William Redwood Wright, of Philadelphia, is president of both companies. The construction work will begin early in the fall.

ELECTRICAL SECURITIES.

According to the sentiment of the commission houses, there has been a decided falling off in the attention which the speculative public has given to the stock market during the past week. This, however, is a normal condition, and was looked for to follow the rapid increase in speculative values which set in about a week ago. Several large interests made a determined stand for a lowering of values early in the week, and the success which was met with was all that could be expected. While this pressure materially reduced the standing of some strong securities, still there is a very decided bullish sentiment among professional traders at large.

Railroad stocks have shown more than usual activity, and the trading in one or two strong securities has been remarkable for the extent of manipulation and the strength which developed under considerable pressure. This has been brought about probably by the continued good showing which railroad earnings are making.

Trade reports covering all sections of the country have been uniformly good, and only where statistics show a reaction consequent upon the heavy volume of business which has been evidenced during the last twelve months has there been any failure to witness a healthy condition.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 22.

New York:	*Closing.*
Brooklyn Rapid Transit	44¼
Consolidated Gas	177
General Electric	162
Kings County Electric	160
Manhattan Elevated	133¼
Metropolitan Street Railway	113¼
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	170

Boston:	*Closing.*
American Telephone and Telegraph	134
Edison Electric Illuminating	235
Massachusetts Electric	79
New England Telephone	126
Western Telephone & Telegraph preferred	80

The American Telephone and Telegraph Company's statement of output of instruments for July shows the total number of instruments outstanding to be 3,540,321, an increase of nearly 400,000 since December, the close of the last fiscal year. The expenditures for construction so far this year, at about $60 per instrument, have been something like $25,000,000. This compares with $37,336,000 for the twelve months of the last fiscal year.

Philadelphia:	*Closing.*
Electric Company of America	8⅛
Electric Storage Battery common	55
Electric Storage Battery preferred	55
Philadelphia Electric	6⅝
Union Traction	43⅞
United Gas Improvement	83¾

It is stated that the surplus earnings of the Philadelphia Rapid Transit Company for the fiscal year ended June 30, 1903, after deducting $500,000 for improvements and fixed charges, including Union Traction 3 per cent guarantee, were about $400,000. The gross earnings were nearly $15,400,000, compared with $14,118,153 in 1902 and $10,381,015 in 1896.

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	140
Metropolitan Elevated preferred	60
National Carbon common	21½
National Carbon preferred	90
Union Traction common	6
Union Traction preferred	32

The stockholders of the Union Traction, West Chicago and North Chicago Traction companies have approved the receivers' plan for reorganization. Seventy per cent of Chicago Union Traction stock was voted at the meeting.

ELECTRIC LIGHTING.

BROWNSVILLE, TEX.—John W. Maxcy, of Houston, has secured a franchise from this city for electric lights, waterworks and telephones.

PRINCETON, N. J.—The ordinance granting the University Electric Power Company right of way through the borough streets has been passed by the council.

WINONA LAKE, IND.—The city council of Warsaw has voted to the Winona Light, Heat and Power Company a fifty-year franchise for heating, lighting and the furnishing of water to the city.

SENECA, S. C.—A corps of engineers is at work surveying Hatton's Ford, on the Seneca River, where a new power company is to be established for the city of Anderson.

PEORIA, ILL.—The electric light company is installing new lamps throughout the city. These are of the latest type, and it is expected that the service will be greatly improved.

JACKSONVILLE, FLA.—The city electric light plant is making arrangements to handle 8,000 more lights this winter. Two new turbo-generators of 200 kilowatts capacity each are being installed.

BIG TIMBER, MONT.—The Cowles Mining Company will install a 500-horse-power electric plant to operate all the machinery in the camp, as well as to light it thoroughly. Work has been commenced on the power-house.

TACOMA, WASH.—The contract for building the power-house of the Puget Sound Power Company, on the Puyallup River, has been let, and work begun. The contract calls for the completion of the plant by December 1 of this year.

EL RENO, OKLA.—John A. Masters and others have purchased the El Reno Light and Power Company's plant for $60,000. A new company will be organized shortly. The plant was built last fall and began to operate in December. It is thoroughly up to date in every respect.

WASHINGTON, D. C.—Proposals will be received for the construction of the following improvements and until the dates given: Conduit and electric wiring in post office at Aberdeen, S. D., September 14; conduit and electric wiring in post office building at Cumberland, Md., September 15; conduit and electric wiring for post office building at Fergus Falls, Minn., September 10.

ROCK HILL, S. C.—It is announced that work is progressing rapidly on the Catawba Power Company's plant on the Catawba River, and that the company will be ready to furnish power in six months, though the entire work will not be completed for twelve months. When finished, the plant will be able to furnish 6,000 horse-power for the entire year, and for about eight or nine months. 10,000 horse-power. Up to date the work has cost more than $800,000. It is stated that the company has under consideration the project of transmitting 3,000 horse-power to Charlotte for lighting purposes.

LEGAL NOTES.

AUTHORITY TO CONDEMN THE RIGHT TO CONSTRUCT A TELEGRAPH LINE—Authority to condemn the right to construct a telegraph line along a railroad right of way is held in Fort Worth & R. G. R. Company *vs.* the Southwestern Telegraph and Telephone Company (Texas), 60 L. R. A. 145, to be conferred by a statute permitting the condemnation of any land, whether owned by private persons in fee or in any less estate or by any corporation, whether acquired by purchase or by virtue of any provision in the charter of such corporation.

WESTERN UNION SECURES A RESTRAINING ORDER—In the United States Circuit Court, District of Wilmington, Del., on August 21, Judge Bradford issued an order temporarily restraining the Philadelphia, Baltimore & Washington Railroad and the Delaware & Virginia Railroad Company from interfering with the property of the Western Union Telegraph Company on the right of way of these railroad companies. The order of Judge Bradford will remain in force until the question has been finally decided by the United States Supreme Court or until the local court makes a further order.

INDUSTRIAL ITEMS.

A NEW TELEPHONE CATALOGUE and up-to-date price list have just been issued and are now being sent out by the Electric Appliance Company, Chicago. Any one in the telephone business who has been missed in the distribution will receive a copy of this catalogue by writing to the Electric Appliance Company, 92 West Van Buren street, Chicago, Ill.

THE SAWYER-MAN ELECTRIC COMPANY announces that to further facilitate the prompt handling of orders, it has recently established a distribution depot at the central stores of the company's terminal warehouse in West Twenty-eighth street, New York city. A million lamps are kept in stock, so that any order can be promptly filled. A similar depot is situated at Thirtieth and Market streets, Philadelphia, and others in Boston, Buffalo, Syracuse, Pittsburg, Charlotte, Chicago, Denver, St. Louis, Atlanta, New Orleans, San Francisco, Seattle and other centres of trade.

THE JOHN M. KLEIN ELECTRICAL WORKS, San Francisco, Cal., will remove on October 1 to a four-story building at 107 Battery street, one block from Market street, which is the centre of the wholesale district. The building is 40 feet by 125 feet and is well adapted for this business. The removal of this works to these large quarters is a consequence of its growth. Mr. Klein is a Utica, N. Y., man, and has the largest electrical establishment on the coast. He started twenty-five years ago in a small store, and now is president and general manager of one of the largest business interests west of Chicago.

THE WALLACE BARNES COMPANY, Bristol, Ct., manufacturer of small springs of every description, has ready for distribution its new catalogue and a new stock sheet. This describes and illustrates a line of fine springs of every variety. The company has on hand a large stock of cold-rolled spring wire, from 0.003 to 0.250 in thickness, and carries a large assortment of steel, brass, phosphor-bronze and music spring wire and also a large variety of flattened wire, both tempered and untempered. The catalogue is full of valuable information on motor spring tests, extension spring tests and other formulæ which it will be of advantage for any one interested in this line to secure.

THE BANNER ELECTRIC COMPANY, Youngstown, Ohio, announces that its business is steadily increasing each month of this year, showing a decided expansion over the business of the corresponding months of last year, the business for some months being more than double. The company has experienced no dull season during the summer, and has kept its plant in continuous operation. A new equipment has been added to its lamp department, increasing its facilities so that it is in a position to meet the increasing demand for Banner lamps. A study of the situation shows that the increase in business is due principally to the high quality of the company's goods. Its record shows that it has invariably retained its customers, proving that Banner lamps are giving satisfactory results to consumers. Agencies have been established in all the principal cities, where orders can be filled direct from stock.

THE THOMAS E. CLARK WIRELESS TELEGRAPH AND TELEPHONE COMPANY, Detroit, Mich., is placing on the market the "Clark Coil" for automobiles, gas engines, etc. The vibrators are made so as to remain in constant adjustment, and the contacts are of such low resistance that the sparks from the secondaries are nearer a flame than a spark. The condensers are treated with special prepared paper which the company states it is impossible to puncture. The primaries are separated from the secondaries by high-grade insulating material, and the core of the coil is so constructed as to reduce to a minimum eddy currents and core loss. The condensers are separated from the coil proper at the point where the secondaries leave the coil, and are insulated at this point with hard rubber. The binding-posts and metal parts are of the best mechanical and electrical construction. All exposed parts are nickel-plated and polished, obviating the danger of rust or corrosion.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has published a new bulletin entitled "The Standard Motor Book." The machines described in this motor book were the earliest types of what is now generally known as the protected type. The company states that this type is now so commonly used that it has been suggested that a more distinctive name be used, and its machines will hereafter be known as the "Standard" motors and dynamos. A number of illustrations show the assembly and construction of these dynamos and motors, and tables are given showing "Standard" dynamo and motor specifications and telegraphic code. There are diagram illustrations giving the frame sizes, a dimension table of "Standard" motors and dynamos, diagrams showing the various connections for shunt, series and compound dynamos and motors, and a supplementary article on the selection, installation and care of motors. This motor book will be sent to interested parties on request.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., reports the following partial list of engine sales for July, 1903: Chicago Beach Hotel, Chicago, one 16 by 36 inch, heavy-duty, direct-connected, Reynolds-Corliss engine; Knox Construction Company, Chicago, two 20 and 40 by 48 inch, heavy-duty, cross-compound, direct-connected, Reynolds-Corliss engines; Richmond City Works, Richmond, Va., one 24 and 36 by 48 inch, heavy-duty, cross-compound, Reynolds-Corliss engine; Barrett Manufacturing Company, Beloit, Wis., one 20 and 40 by 48 inch, heavy-duty, cross-compound, Reynolds-Corliss engine; American Aristotype Company, Jamestown, N. Y., one 18 by 36 inch, girder frame, Reynolds-Corliss engine; Stilwell-Bierce & Smith-Vaille Company, Dayton, Ohio, one 16 by 42 inch, girder frame, Reynolds-Corliss engine; Fourche River Lumber Company, Chicago, one 24 by 48 inch, heavy-duty, Reynolds-Corliss engine; one 20 by 42 inch, heavy-duty, Reynolds-Corliss engine; J. I. Case Plow Works, Racine, Wis., one Reynolds air pump and jet condenser; Consumers' Heat and Electric Company, Bloomington, Ill., one 20 and 32 by 36 inch, heavy-duty, cross-compound, Reynolds-Corliss engine; Union Sugar Company, San Francisco, Cal., one 18 by 36 inch, girder frame, Reynolds-Corliss engine; Canton Oil Mill Company, Canton, Miss., one 16 by 42 inch, girder frame, Reynolds-Corliss engine; Henry Du Pont, Wilmington, Del., one 20 by 42 inch, girder frame, Reynolds-Corliss engine; Olds Motor Works, Lansing, Mich., one 16 by 42 inch, girder frame, Reynolds-Corliss engine; The Clayton Oil Mills, Clayton, N. C., one 18 by 42 inch, girder frame, Reynolds-Corliss engine; The Homestake Mining Company, Lead, S. Dak., one 15-32-34 by 42 inch, combined Hor-Vert, triple expansion engine, three 320-horse-power, Sederholm boilers; Lacey-Bukk Iron Company, Birmingham, Ala., one 44 and 84 by 60 inch, vertical, standard furnace, plowing engine; C. A. Macdonald, Chicago, one 16 by 36 inch, girder frame, Reynolds-Corliss engine, without crank, crank-shaft, wheel, etc.; Arkansas City Milling Company, Arkansas City, Kan., one 22 by 42 inch, heavy-duty, Reynolds-Corliss engine; Manhattan Rubber Manufacturing Company, Passaic, N. J., one 24 and 40 by 42 inch, heavy-duty, tandem-compound, Reynolds-Corliss engine; Charles B Pride, Appleton, Wis., one 18 by 36 inch, heavy-duty, Reynolds-Corliss engine, substituted for 14 by 36 inch, sold May 25, 1903; Columbus, Buckeye Lake & Newark Traction Company, Columbus, Ohio, one 34 and 68 by 48 inch, vertical, cross-compound, condensing, heavy-duty, Reynolds-Corliss engine; Lock, Moore & Company, Limited, Westlake, La., one 24 by 48 inch, heavy-duty, Reynolds-Corliss engine; Georgia Cordage Mills, Decatur, Ga., one 16 by 42 inch, heavy-duty, Reynolds-Corliss engine; Marquette Cement Manufacturing Company, La Salle, Ill., one 20 by 42 inch, heavy-duty, Reynolds-Corliss engine; Coe Brass Manufacturing Company, Terrington, Ct., one 22-44 by 42 inch, and one 19-38 by 42 inch, combined Hor and Vert, compound Reynolds-Corliss engines, two air pumps and two jet condensers; Charles Waite, South Dakota, one 12 by 30 inch, girder frame, Reynolds-Corliss engine; two 70-horse-power, 54 by 16 inch, tubular boilers, one No. 5 feed-water heater; The Gauley Company, Camden-on-Gauley, W. Va., one 16 by 36 inch, heavy-duty, Reynolds-Corliss engine; Rock Hill Water, Light and Power Company, Scranton, Pa., one 20 by 42 inch, girder frame, Reynolds-Corliss engine; Memphis Consolidated Gas and Electric Company, Memphis, Tenn., one 27-72 by 48 inch, horizontal, cross-compound, heavy-duty, direct-coupled, Reynolds-Corliss engine.